THE EFFECT OF CHARGING AND FINANCING MODES ON OPTIMAL CLUB GROWTH RATES

by

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I. INTRODUCTION

Club theory literature has provided useful paradigms to examine a variety of collective responses to the provision of club goods, i.e. impure public goods where both exclusion and crowding externalities are possible. However, club design issues involving intertemporal choices about growth and intergenerational cost responsibility have not been completely resolved. Moreover, the application and testing of club paradigms have been limited by their abstract nature. In this paper we attempt to extend and refine club theory by examining in more detail the choice of various charging-financing regimes on growth. This is done in the context of club type collective responses to long run supply problems in growth contexts.

By ignoring the distinctions and complexities of actual charging and financing modes, extant club literature has obscured several important analytical and policy issues. Our model examines charging-financing modes in observable and measurable terms. For concreteness, we develop the model in the context of urban water supply considered as a club for which charging and financing decisions must be made.

We show that there are important distinctions that have to be made in identifying basic characteristics of charging-financing modes available to entities providing collective responses in club-like supply situations. In such situations the impure public good nature of the good being supplied generates choice problems in the two dimensions of central concern in the club literature (Buchanan, 1965; Cornes and Sandler 1986) These are 1) choices about membership size in order to achieve maximum cost sharing and and thus reduce member outlays; and 2) choices about membership size so as to avoid or optimize the congestion and crowding costs associated with excessive club size. Per member cost shares are minimized by maximizing "membership" while crowding and congestion are avoided by minimizing membership in the club.

The optimal response to this basic trade-off of central concern to club theory becomes difficult to conceptualize and implement in long run growth choice situations facing fiscal clubs existing all around us. These include public sector or quasi-public sector entities such as local government units and/or fiscally autonomous government enterprises such as urban water supply agencies. Regulated public utilities have similar problems. Such club like organizational entities have to cope with growth problems involving replication of similar facilities and/or open ended infrastructure networks.

By focusing on urban water supply agencies and similar club-like entities we can be more specific in identifying and evaluating charging or financing regimes actually found in practice. One of two primary charging modes used by urban water agencies is an essentially uniform user charge imposed on all members (users) that we characterize as a "pure club" charging mode; i.e. cost sharing is completely uniform and homogeneous across all members. We call this the <u>club</u> charging mode. Second is a differentiated charge consisting of a uniform periodic charge on all members to recover one set of costs while some one time charge (i.e. an entry fee or initiation charge) is imposed on new entrants in order to recoup the attributable capital costs associated with those new club members or entrants. (Usually these charges do not recoup or offset crowding costs). This type of one time, up front charge has been given several names in practice, but we will use the label "<u>self</u> charging". An example is the "development charges" used by organizational entities supplying infrastructure net work supply facilities such as water.

Regardless of the charging mode being utilized, finance can be achieved either by internal means, (i.e. retained earnings or depreciation accruals) or external means (i.e. debt) with the resulting debt service and eventual repayment coming out of revenue generated by whatever charging modes have been selected by the club.

The equal uniform, undifferentiated, homogeneous cost sharing assumed in much of the club theory literature is irrelevant or misleading for identifying and evaluating cost sharing in more realistic situations involving growth and multiple generations of users (members). Thus it is imperative that more detailed and realistic charging and financing distinctions must be incorporated into the analysis if meaningful or relevant results are to be achieved.

We shall demonstrate that the choice of charging/financing mode can have a significant impact on both the nature and extent of cost sharing on the one hand, and the desirability of more growth on the other. (This is true at least from the perspective of the early entrants who presumably have control over the mode of charging as well as the rules that determine growth rates.) An awareness of these charging and financing modes and their effects in a growth context can be shown to be important in shaping the two aspects of club size or growth rates already mentioned: the nature and extent of cost sharing and the acceptability of more growth or larger club sizes.

We evaluate this complex of issues by addressing two related questions:

1) Given likely concerns for cost sharing and congestion avoidance, what charging-financing modes or regimes would be likely to be selected by fiscal clubs in a growth context?

2) If a club is forced to use some charging-financing mode or regime for some institutional reason, what is the likely effect of that charging regime on the club's perspective of tolerable or desired growth? i.e. would a club locked into a charging mode that might inflict high costs of growth on the early entrants limit growth in order to avoid those costs?

Outline of the Paper

In the next section we develop an analytic framework that highlights the nature of the charging-financing choices and their likely impact on club members' perceptions of the advantages or disadvantages of growth on the cost sharing choice of central concern to club theory.

In section III we use the model developed in section II to examine the influence of expected or actual growth on the choice of charging-financing mode appropriate to a club. We find that in general the greater the growth the less likely pure club cost sharing will be desired by founding club members (who determine the charging mode).

Section IV assumes that the club must use pure club charging and asks how members might respond by controlling the rate of growth of the club. We find that under many plausible conditions, the club members will limit the growth of the club in order to avoid perverse cost sharing. Moreover, we find that even when self charging is the preferred (least expensive) mode, the club may still wish to limit growth in pursuit of rents, that is, to avoid adverse capitalization effects resulting from crowding and congestion associated with growth.

II. CLUB CHOICE AND CHARGING-FINANCING MODES: AN ANALYTICAL FRAMEWORK

We have identified four different regimes for financing investments by clubs, each of which has two aspects of current interest: the charging scheme and the source of funds. A club such as a water utility (which will serve as our recurring illustration) may levy charges in accordance with the different capital costs attributable to each user (self finance) or in the manner of a fiscal club, involving some degree of cross subsidy among members. In either case, the immediate source of funds may be internal (e.g., user fees, development charges, or taxes) or external (bond sales or other forms of debt).

We proceed by deriving the costs, properly discounted, imposed on the current and each succeeding cohort of water users as a result of following a stated time path of investment in water system capital. These costs differ according to the financing-charging regime adopted, thus permitting comparisons on the basis of (discounted) costs. All costs are discounted to some time $t \geq 0$, taken as a time when a new user enters the utility system by, say, constructing a new house, adding the requisite connection to the water distribution system and becoming a customer of the utility. Time $t = 0$ represents the origin of the system. We identify a cohort of water users with the time of entry of a new housing unit into the water utility system.

The analysis to follow assumes no social welfare function, but we can assume that any club member prefers to pay a smaller rather than a larger share of capital costs attributable to his entry into the club.

Under self financing, the individual may choose whether to borrow or to use internally generated funds such as personal savings. With club financing this decision lies with the "club" or utility governing body. In either case, all discounting occurs from the viewpoint of the individual user, not the utility system as a whole or its managers or directors. The private rate of time preference, ρ, is thus the appropriate discount rate. For analytical convenience, we assume all growth and discounting occur continuously over time.

The amount of capital per connection differs substantially between water systems and, more importantly, between different types of connections--single family residential, apartment, industrial, hotel. Our interest, however lies in the pattern of changes over time rather than between types of users, so we think in terms of an average of capital requirements, over all connections. At time t, we denote this value k(t). Over time, k(t) varies for several reasons. First, the water system may encounter economies or diseconomies of scale. Second, technological changes may alter capital requirements. Third, derived demands for water capital may rise or fall depending on demand for lawn and garden areas, water intensive appliances, services, productive processes or the like. Fourth, inflation tends to raise the nominal value of capital. Fifth, the new entrants may impose crowding or congestion externalities if infrastraucture associated with the club is not infinitely replicable at constant cost. For example, scarcity value of water will rise as more distant sources of supply have to be tapped or as more and more people use a river or lake for recreation.[1] The net effect of these changes is uncertain in principle. However, a study of long term trends will be adequately served if we simply assume that k(t) grows at a constant rate c.

A. Self charging using internal financing

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[1]Scale economies, technological changes, derived demands and inflation represent actual dollar outlays relevant to cost sharing. Crowding and congestion costs, by contrast, are often not monetized and we treat them separately. In effect, this recognizes the distinction common in club literature, explicit costs vs. implicit crowding or congestion costs.

Consider an individual water user who contemplates entering the club by "buying" a new connection to the water system at some time $t \geq 0$. With $k(t)$ growing at the (instantaneous) rate c, a new connection will require outlays of $\$k(0)e^{ct}$. In the present internal funds case, payment for the capital occurs at the time of entry, t, so discounting is unnecessary. The value at time t of costs of connection is simply

$$V_s^i(t) = k(0)e^{ct} \tag{1}$$

where the superscript i specifies internal sources of funds and the subscript s denotes the self financing regime.

B. **Self charging using external financing**

The user may borrow to pay for his water connection. Such costs typically enter into a mortgage when the developer provides the attributable infrastructure. But one may also consider them separately, as though under a home improvement loan or as if the utility had established a special assessment district with provisions for the new user paying off the assessment with interest over time. Thinking in terms of a loan, let d denote the interest rate and m the loan maturity, in years, both of which we take to be constant over time.

The principal of such a loan must cover the same costs as shown in equation (1), $\$k(0)e^{ct}$, assuming the entire capital outlay is financed. Thus repayment must occur at the rate, A, defined by

$$k(0)e^{ct} = \int_t^{t+m} A\, e^{-d(\tau - t)}\, d\tau$$

$$= A\left(\frac{1 - e^{-dm}}{d}\right)$$

or

$$A = k(0)\ e^{ct}\left(\frac{d}{1-e^{-dm}}\right)$$

The bracketed term is the standard capital recovery formula assuming continuous compounding of interest and repayment of principal (see for example Theusen, Fabrycki and Theusen, 1971).

A water user with time preference rate ρ discounts this stream of payments to a value at the time of entry, t

$$V_s^x(t) = \int_t^{t+m} k(0)e^{ct}\left(\frac{d}{1-e^{-dm}}\right) e^{-\rho(\tau-t)}d\tau$$

$$= k(0)\ e^{ct}\left(\frac{d}{\rho}\right)\left(\frac{1-e^{-\rho m}}{1-e^{-dm}}\right) \qquad (2)$$

where $V_s^x(t)$ denotes the value, discounted to time t, of costs under the self financing regime (s) using external funds (x).

C. **Club charging with internal financing**

One could design "clubs" with a wide array of provisions for distributing capital costs across "members" and time. Many utilities, for example, levy "postage stamp" user charges invariant to location, time of use or time of entry. A property tax levied by a local government would serve the same purpose. For the present, assume that each water user (club member) pays an equal share of total investment costs for a given year, in the case where the utility relies entirely on internal fund sources, or an equal share of accumulated amortization payments under the external funding case considered in the next section.

In either case, the club must invest at a rate determined by the growth of capital required per connection as well as the number of connections. The former, as before, will be $k(0)e^{ct}$ at time t. If the number of connections h(t) grows at rate g, then the number of new connections per period is gh(t), and the total number of connections in service is $h(0)e^{gt}$. Suppose the club assesses each member an equal share of new capital costs and this obligation will continue from time t when a new member enters the club, through some unspecified future point $t + \mu$, $\mu > 0$. Given the rate of time preference ρ, this commitment has value, discounted to time t, of

$$V_c^i(t) = \int_t^{t+\mu} \frac{[k(0)e^{c\tau}][gh(\tau)]}{h(0)e^{g\tau}} \; e^{-\rho(\tau-t)} \, d\tau$$

where $v^i_c(t)$ indicates the club financing arrangement using internal sources of funds. Substituting $h(\tau) = h(0)e^{g\tau}$ and integrating yields

$$V_c^i(t) = \frac{k(0)\ g\ e^{\rho t}\ e^{(c-\rho)t}}{c - \rho}\ [e^{(c-\rho)\mu} - 1]$$

Finally, if the member's commitment lasts indefinitely,[2] i.e., if $\mu \to \infty$, then we have

[2] A water user could presumably end his membership by moving outside the utility's service area. But the club would reasonably attach the obligation of membership to structures, not individuals, in which case all water system liabilities would become capitalized into the value of the building, whoever owns it. Hence we let $\to \infty$.

$$\lim_{\mu \to \infty} V_c^i(t) = \frac{-k(0)\ g\ e^{ct}}{c - \rho} > 0 \tag{3}$$

assuming $c - \rho < 0$. If this latter condition fails, then $V_c^i(t)$ diverges; under the internally funded club regime, discounted costs become infinite.

D. Club charging using external financing

The expression for discounted value of the cost stream under a club regime using external funds is much more complex than in preceding cases. As before, water system investment proceeds along the path $k(0)e^{ct}gh(t)$. In the present case the club has borrowed to finance past years' investment and will continue to do so for the present and future. We split the analysis into two segments: first for years $t \geq m$ (m = maturity of debt instruments) and then for years $t < m$.

Consider first the entrant in some year $t \geq m$. Such an individual must take on an obligation for (a share of) all debt outstanding at time t. The debt incurred during any period of length $d\theta$ engenders amortization of $k(0)e^{c\theta}gh(\theta)d/(1 - e^{-dm})d\theta$, assuming as before continuous compounding and repayment processes. By the time of the member's entry in some year $\tau \leq t$, those payments will have accumulated to the amount

$$\int_{\tau - m}^{\tau} k(0)e^{c\theta}\ g\ h(\theta)\ \left(\frac{d}{1 - e^{-dm}}\right)\ d\theta$$

The fiscal club member stands responsible for only a $1/h(0)e^{g\tau}$ share of this amount, on the equal cost distribution assumption. However, membership obligates him to repay a portion of future debt as well, up to some time μ. Discounting the entire obligation to time $t \geq m$ at the rate of time preference, ρ, we have

$$V_c^x(t)\Big|_{t\geq m} = \int_t^{t+\mu}\int_{\tau-m}^{\tau} \frac{k(0)e^{c\theta}gh(\theta)}{h(0)e^{g\tau}} \left(\frac{d}{1-e^{-dm}}\right) e^{-\rho(\tau-t)}\, d\theta d\tau \qquad (4)$$

Using the result $h(\theta) = h(o)e^{g\theta}$ as before and integrating yields the discounted (to time t) cost of the fiscal club member's obligation:

$$\frac{k(0)gde^{\rho t}\,[1-e^{-(c+g)m}]}{(1-e^{-dm})\,(c+g)\,(c-\rho)}\, e^{(c-\rho)t}\,[e^{(c-\rho)\mu}-1]$$

Taking the limit as $\mu \to \infty$, given $c - \rho < 0$,

$$\frac{-k(0)ge^{\rho t}\,e^{(c-\rho)t}}{(c-\rho)} \left(\frac{d/(1-e^{-dm})}{(c+g)/[1-e^{-(c+g)m}]}\right)$$

or, finally,

$$V_c^x(t)\Big|_{t\geq m} = \begin{cases} \dfrac{-k(0)ge^{ct}}{c-\rho}\;\dfrac{d/(1-e^{-dm})}{(c+g)/[1-e^{-(c+g)m}]} \\ 0, \quad \text{for } t < m \end{cases} \qquad (5)$$

Note that with c, g, d, ρ, m > 0, and $c-\rho < 0$, we have $V_c^x(t) > 0$ for $t \geq m$.

During the early years of the fiscal club's existence, however, equation (4) accumulates too much past investment. Taking t=0 as the point of origination of the club, then for any $t < m$, $t - m < 0$, and (4) would imply positive investment in years prior to the system's beginning. The inner integral should extend backward in time only to zero for investment occurring within the first m years of the system's existence. For a water system entrant at time $t < m$, then, we should have for $t < m$

$$V_c^x(t)\Big|_{t<m} = \int_t^m \int_0^\tau f(\cdots)\, d\theta\, d\tau + \int_m^\mu \int_{\tau-m}^\tau g(\cdots)\, d\theta\, d\tau \qquad (6)$$

where the integrands $f(\cdots)$ and $g(\cdots)$ carry over intact from (4) except that the domain of $f(\cdots)$ is $0 < t < m$ and of $g(\cdots)$ is $t \geq m$. The first term accumulates values from the time of entry, t, until year m; the latter incorporates the (discounted) cost occurring from year m on. Integrating as before yields the woefully inelegant result

$$V_c^x(t)\Big|_{t<m} = \begin{cases} \dfrac{k(0)gde^{\rho t}}{(1-e^{-dm})\ (c+g)} \left[\dfrac{e^{(c-\rho)m}-e^{(c-\rho)t}}{c-\rho} + \dfrac{e^{-(g+\rho)m}-e^{-(g+\rho)t}}{(g+\rho)}\right] \\ \qquad \dfrac{k(0)ge^{\rho t}e^{(c-\rho)m}}{c-\rho} \left[\dfrac{d/(1-e)^{-dm}}{(c+g)/[1-e^{-(c+g)m}]}\right]\ ; \\ 0, \quad \text{for } t \geq m. \end{cases} \qquad (7)$$

The discounted capital cost equations (1), (2), (3), (5) and (7) are summarized in table 1. They permit the measurement of the full capital costs

V facing new entrants into a fiscal club under a wide variety of contextual conditions for each benchmark charging-financing regime examined. Clearly, this new-entrant-specific capital cost share will vary as a function of the choice of charging-financing regimes. In following sections we examine how clubs make the charging-financing choice as well as how this choice affects other aspects of club behavior regarding growth.

III. DE NOVO CHOICE OF CHARGING-FINANCING MODE

We are now in a position to evaluate the preferences of different cohorts of entrants for the four charging-financing modes available to a club. We assume that each cohort of users ranks the modes in order to minimize its own cost share emerging from the parameters defining the context in which the club operates. Since actual or expected growth is one such parameter, growth can be seen as a determinant of the preferred charging-financing mode. Charging-financing modes will be preferred according to the manner in which they accommodate perceived standards of fairness for cost sharing in the face of growth.

Equations (1), (2), (3) and either (5) or (7) as appropriate, indicate the discounted cost, to a cohort of new members, of an investment program required to satisfy anticipated growth in water demand under each of the four charging-financing regimes. We turn now to comparisons of these new-entrant-specific cost shares under the different regimes.

In all cost comparisons, we take the viewpoint of a new water user entering the system at time t. We assume initially that the design of the project is independent of charging-financing considerations. Thus no cohort could, for example, construct poor quality system additions in order to minimize current outlays, only to pass along high operation, maintenance or replacement costs to some future generation. Conversely "gold plating" is assumed away even in the context of more permissive financing arrangements. Given these assumptions, benefits of the investment program are unaffected by the choice of charging-financing regime. Second, we assume that financing can be arranged at a given interest rate d whether through a club or individuals. In practice, tax or loan security considerations give an advantage to broader based governmental or quasi-governmental "club" structures in this respect, but for simplicity we ignore this consideration. Third, we assume that the marginal utility of income remains constant over time, so that intergenerational comparisons can be made with simple discounting procedures. Finally, we consider here only the polar cases rather than any possible combinations of internal or external funding or of self and club charging.

Table 2 displays the six pairwise cost comparisons arising from the four charging-financing regimes, along with conditions on d, ρ and c+g leading to cost minimizing choice of regime. Each condition has an intuitive interpretation. First, lines 2 and 3 in table 2 indicate that whenever the rate of time preference ρ falls short (for example) of the rate of growth of investment c+g, a self-charging arrangement costs less for every cohort than the corresponding club scheme. Positive time preference diminishes the current significance of any future obligations, but not fast enough to offset growth in the future obligation. Hence the individual user will incur lower costs by assuming responsibility for the one time, up-front cost of his own water capital rather than by being subsidized in return for agreeing to share in attributable capital costs of future water system expansion.

Given a preference for self charging, deciding between internal and external sources of funds becomes a matter of comparing the "price" of borrowed funds to the "price" of using internal funds. As shown in line 1 of Table 2, $d < \rho$, for example, indicates that the user can borrow at a rate less than the rate at which he is willing to trade future for present consumption and so will minimize costs by using external funds rather than using his own available assets.

Somewhat less obvious in meaning is the condition in line 4: given $\rho > c+g$, so that club charging holds the cost edge, the decision between internal and external sources of funds rests on the relationship between the borrowing rate of interest d and the growth rate of investment c+g. The similarity in form between bracketed terms in lines 4 and 5 suggests that c+g plays a role for the club analogous to the rate of time preference ρ for individuals. If the club uses internal funds, it must raise user fees or other club assessments at the rate c+g (assuming no changes in reserves). Water users can pay these higher bills only at the cost of some foregone consumption. But the club can forestall such costs in some degree by borrowing to finance the investment and raising charges only enough to cover debt service. Hence if interest charges accumulate at a rate d below c+g, the rate at which investment grows (and at which foregone consumption would have to rise), borrowing would be advantageous. By contrast $d > c+g$ indicates that interest compounding would outweigh increases in foregone consumption. It would cost less to divert funds from current consumption than to commit the club to a borrowing program, the repayment of which requires an even greater decrease in (properly discounted future) consumption.

The conditions stated in lines 5 and 6 of table 2 are, in contrast to the previous four, only sufficient, not necessary. But the same general interpretations follow. In line 6, for example, $d > \rho$ favors internal over external financing (compare with line 1) while $\rho > c+g$ favors club over self charging (compare with lines 2 and 3).

Note that the derivatives of all six cost difference expressions in table 2 take the same sign as the cost difference itself. Thus at least for $t \geq m$, the cost advantage will not switch from one financing-charging mode to another due simply to the passage of time; there will be no conflict between interests of different cohorts. However, this result sometimes fails when $t < m$ and the external club mode is involved.

Three general rules summarize the foregoing discussion:[3]

1. In self-charging system, if $d < \rho$, borrowed or external funds will minimize costs for all cohorts, while if $d > \rho$ internally generated funds cost less from the viewpoint of any cohort of water users.
2. If $\rho > c+g$, either club regime has lower discounted costs than the corresponding self regime; while if $\rho < c+g$, self charging holds the advantage.
3. In a club charging system, if $d < c+g$, costs are lower using external funds; $d > c+g$ makes internal funds the less costly arrangement.

Figure 1 illustrates these rules. Here, $d > \rho$, so $V_s^i < V_s^x$. With $\rho > c + g$, club modes are cheaper than self charging for most cohorts. And since $d > c + g$, $V_c^i < V_c^x$, except in the few earliest years. Note the "crossover," however, at about $t = 4$ in the case shown in figure 1. Founders would benefit

[3] For all cases involving external club financing, these rules hold only for $t \geq m$. Also, all cases must satisfy $c - \rho < 0$.

by using club charging and debt financing while later cohorts would prefer self charging with internal finance.

These rules have several implications for selecting a preferred charging-financing mode, given a growth rate g of club membership. Note first that the higher is g, cet. par., the greater the chances that the club will select self charging over club. This tendency will be compounded the greater is the growth rate of capital costs c. In these circumstances, the sharing of costs made possible by a club charging mode becomes perverse from the standpoint of early entrants who must anticipate high shares of rapidly rising future costs. These high cost shares can be avoided by adopting a self charging regime.

On the other hand, even with high anticipated growth, if ρ is high enough and c negative, club charging would still be the preferred mode. In this case any cohort of club members could still realize cost sharing gains: with $c < 0$ the greater the growth the greater the cost sharing benefits to be gained.

A. Numerical Simulations

Tables 3 and 4 present illustrative values of V's resulting from various permutations of the relevant parameters. These values confirm propositions developed analytically and facilitate insight into other determinants of the new member-specific cost of club entry under various charging-financing modes, given the growth rate of the club. The tables also illustrate the sensitivity of V to changes in parameters. In all cases we assume k(0)=\$1.00.

Full Equivalency Case. In accordance with table 2, when $\rho = d = c+g$, $V_s^i = V_s^x = V_c^i = V_c^x$; the capital cost responsibility facing a new club member is invariant to the charging-financing mode adopted. This result appears clearly in the simulations shown in rows 6 and 12 of table 3, in the upper left and lower right banks of data.

Advantages of Cost Sharing Under Club Charging. By its concept and construction V_s^i indicates the amount a new member costs the club in attributable capital outlays. If a particular entrant pays less as a result of club facilitated cost sharing, the new member benefits from the selected charging mode. This holds for all member cohorts, for any time of entry $t \geq m$. Table 3 shows that as long as $\rho > c + g$ the distributed new member cost V_c is less than V_s for either of the self charging modes.

Disadvantages of Cost Sharing Under Club Charging. Whenever $\rho < c + g$, $V_c > V_s$. This illustrates what we call "perverse" cost sharing. Because the costs to be shared rise over time, earlier entrants, who have part of the costs paid for by the club in return for their obligation to pay part of the capital costs of future entrants, are committed to a higher cost obligation than would have been the case had they borne only their own capital costs. Given ρ, the incidence and magnitude of perverse cost sharing will tend to be larger, the greater the values of c and g.

Effect of Club Growth Rates on Cost Sharing. Table 4 illustrates the effect of club growth rates on the costs of new members. Each entry represents the difference in the present value of new-entrant-specific costs between some self charging and some club charging regime, computed from the equations in table 2. Clearly, club charging loses its cost edge as the growth rate rises. When there is an ever growing number of new entrants requiring ever growing amounts of capital, early entrants must bear a much greater cost sharing responsibility in a club charging context than had they not committed themselves to such an open ended arrangement.

Impact of the Rate of Time Preference, ρ. As seen from analytics and numerical simulations, the lower the rate of timte preference ρ the greater the absolute and relative cost of the club approach to charging, cet. par. For a given c + g value, the deferral of payment of cost responsibility inherent in the club charging approach is more valuable the higher the rate of time preference. However, as the rate of time preference declines, as in the right hand banks of data in table 3, there is a pronounced increase in magnitude of the V_c values. With higher time preference, the value of the deferral of cost responsibility declines as reflected in the increase in present value of the subsequent club user charges required to pay those future cost recoupment responsibilities inherent in club charging. This increase in the relative cost of club modes is compounded as either c or g, or both, increase in magnitude.

Thus we can generalize that other things equal, the lower the rate of time preference the greater the chance that founding members of a club will favor self charging as the means of capital cost recoupment. By the same token, any increase in the growth rate will tend to result in a preference for self charging, the lower the rate of time preference of the founding members.

IV. CHOICE OF CLUB GROWTH RATE WITH A GIVEN CHARGING MODE

Selection of a club or self charging regime, particularly in public sector activities, is almost a constitutional matter. Once made, this decision establishes a fundamental rule for its members and is difficult to alter even in the face of changes in the parameters which if known initially would have led to a different choice. However, club members may have policy control over certain parameters allowing them to minimize the adverse effects of having to use less desirable charging modes. In particular, faced with increasing cost shares or congestion costs, club members may try to limit growth.

The most obvious case where a generation of existing members might try to limit growth in order to minimize perverse cost sharing effects would be if the club was locked into a pure club charging mode in a situation where the c parameters had high positive values. As described in section II, in such cost situations, the higher the growth, g, the greater the growth of cost responsibilty of early members beyond what they themselves occurred.

Figure 1, as noted earlier, illustrates one case where, even with an unchanging growth rate, founding generations would minimize their cost responsibility by establishing a club charging system. The rather high growth rate assumed there changes the outlook for cohorts entering the club in year four and beyond, although early cohorts would continue to benefit from club charging as time goes on. Figure 2 shows another ranking reversal, this one the result of a jump in the growth rate from two to three percent annually, while other parameters remain constant. This time, all cohorts would gain by switching, if they could, to an internal-self regime after the growth rate spurt in year 30.

In order to address this question it is necessary to adopt some benchmark for acceptable cost shares, particularly in a growth situation. One such benchmark is the amount each cohort of new entrants would pay had a self finance charging regime been adopted by the founding cohort. This is an appropriate benchmark since the club would have been using the self charging mode <u>if</u> it had control over the charging mode. Lacking such control, it does the next best thing available to it; it limits growth to a level that would generate essentially the same cohort specific costs that would have prevailed had the club used the preferred self charging regime.

On the basis of the model developed in Section II this limit to acceptable growth, g_{max}, can be defined as ρ - c. g_{max} is the maximum growth rate that could be tolerated if the V_c values for each cohort were to be kept equal to or less than what would be observed under a self charging regime. Thus, by controlling the growth rate of its members, a club locked into an undesirable pure club charging mode could avoid the perverse cost sharing effects otherwise associated with the less desired charging mode.

Moreover, to the extent there were any crowding or congestion costs associated with club growth, the constrained growth would address that concern. If there were a very pronounced crowding and congestion cost gradient, growth might be limited even more than would be required to avoid a perverse cost sharing effect on existing members of the club. Unlike the paradigm usually suggested in club theory, both the cost sharing and the congestion minimization concerns work in the direction of smaller size or lower growth.

The primary question considered in this section gives rise to a series of related club theory issues dealing with the time and the manner in which any charging-financing mode is selected or changed, and what set of club members controls the process. An appropriate charging mode for a particular club at one point of time may become obsolete as the underlying parameters change. For instance at the initiation of the club, c may be negative, with the result that the early or founding members knowingly and correctly select the pure club approach as the most appropriate mode of charging; i.e., the mode that reduces its own future cost shares. But over time c may rise and/or the perceived ρ may decline. In view of this change the existing members of the club may prefer to shift to a self charging mode of cost recovery, particularly if g is high or expected to rise further. If the existing members of the club controlled the charging mode, a switch from pure club to self--charging mode is likely to be made.

However, the assumption that the early "charter" members, or even the existing members of the club determine the charging rules, regardless of their motivation or objective function, may be open to question in the local government or public enterprise context of central interest to this paper. Once a political process is recognized, it is less obvious who controls the selection of the charging rules. For one reason or another, the new members or even potential new members of the club may have political influence even if not present to vote in large numbers. This indirect representation might occur for instance in the case where the developers or land owners, seeking rents that can be achieved through greater growth, become effective surrogates for the new or potential members of a local government club. Developers would want to facilitate growth by reducing as much as possible the costs of growth internalized on the new entrants who may have a high price elasticity of demand for the houses or land offered. Thus, a pure club charging mode may be used even if it is contrary to the perceived interests of the majority of existing members or early entrants. Pure club financing explicity shifts the costs of growth to the existing club members through cross subsidization.

The choice of a club growth rate may become important even in the case where the self charging mode is being used, either by choice or because of an institutional constraint. Since the size of entrant specific cost shares or responsibility is independent of the growth rate, there is no need to limit growth in order avoid perverse cost shares, as in the case considered at the outset of this section. However, there remains the concern to minimize crowding and congestion costs, a purpose that obviously can be achieved by limiting growth independent of any concern for controlling runaway cost shares.

If crowding and congestion costs associated with growth are very great, the club may prefer zero growth since there are no offsetting benefits in the form of favorable cost sharing when the self charging mode is being used. However, the very use of self charging facilitates a means of providing compensation to existing members for the adverse crowding effects of growth. This vehicle for compensation forms the basis for defining an acceptable growth rate, even in the face of growth induced crowding costs.

Under self charging, as the cost of installing a new water connection, for example, rises, the development charge assessed on new structures must rise apace. Existing connections substitute for new connections, however, so the development charge generates a rent on existing structures. High development charges thus help to form a price umbrella over existing structures. This capitalization of the value of development charges constitutes a compensation, albeit of undetermined degree, for growth induced crowding and congestion costs encountered by early club members. Indeed, one might define "permissable" growth as that rate for which crowding and congestion costs remain below capitalization benefits. As long as the negative capitalization arising from growth induced disamenities does not exceed the positive capitalization effects resulting from the price umbrella arising from development charges, growth would be acceptable. Thus, given a self charging mode it is possible to infer an acceptable or target growth rate.

V. SUMMARY AND CONCLUSIONS

The determination of club behavior in a long run growth context is more complex than the conventional club theory literature suggests. For one thing there is a wider variety of alternative charging and cost recoupment practices available to clubs than is usually recognized in the literature. The club's choice of these alternative charging and financing modes will be influenced by perceptions of actual or expected growth of the club. This sensitivity of charging mode preferences to growth results from an understandable reluctance of any group of club members to be adversely impacted by perverse cost sharing, i.e. the imposition of heavier then necessary cost sharing responsibilities in some types of club provision situations. If rates of time preference are relatively low or the incremental capital requirements associated with new members is high and growing, the organization will tend to avoid the selection of club charging arrangements. With low rates of time preference and growing capital requirements per new member, higher growth rates will tend to make sure club charging modes even less desired by the early entrants to the club. Since the founders and early members of a club are likely to control the charging and financing rules used by the club in the future, their concerns over future cost sharing will be instrumental in avoiding pure club charging modes, and may even hinder the formation of club like arrangements to begin with.

Growth or expected growth will influence club behavior even where the charging regime is institutionally fixed. If locked into a club charging mode, the club can avoid or minimize any perverse cost sharing that might otherwise result by limiting or constraining growth. By constraining the growth rate, any cost sharing imposed on the early members resulting from the club charging mode can be limited to that which would have occurred under more appropriate cost sharing modes, i.e. self charging.

The club may be interested in limiting growth even when the self charging mode is used. By nature, perverse cost sharing per se is avoided by the early members of the club regardless of the circumstances. However, undesired crowding and congestion costs may still be imposed on club members as a result of growth. Such costs can be avoided by preventing any growth whatsoever. However, if some amount of growth is unavoidable, it would be acceptable up to the point where the negative capitalization effects of such growth do not completely offset the positive capitalization effects resulting from the use of self charging.

Impact of the Financing Choice. The choice of charging mode is the primary determinant of relative cost shares across cohorts of club entrants, (except possibly for a period never longer than the maturity of debt instruments at inception of the club.) New entrants using a club charging-external finance regime could lower their cost shares below the long run sustainable level during this start up period, as depicted in figure 1. Under the club mode, this would be particularly costly for future entrants if debt finance were abused. This would occur if external finance were used when the interest rate d exceeds the rate of time preference, ρ, or if an excessively long debt maturity period were used. This would result in an even greater disparity between the new entrants' cost under a pure club approach and that under a self charging approach than would already exist under an internal finance mode.

If the rate of interest on debt was below the rate of time preference the cost imposed on new entrants under an external-club mode would fall below that of an internal finance-club charging mode. However, in the cases where c is positive and g is high, such a cost preference in favor of external finance would not be enough to make club charging the preferred mode relative to self charging. In short, the charging and related cost sharing considerations examined in this paper drive the choice, with any favorable external financing concerns being inadequate to reverse the choice, made on charging grounds alone, in favor of club charging.

NOTATION

$k(t)$ = Capital required per club member in year t

c = rate of growth of $k(t)$ over time

$h(t)$ = number of club members at time t

g = rate of growth of club members

t = time (assumed continuous)

d = rate of interest for borrowing

ρ = rate of time preference of club members

m = maturity (in years) of any debt instruments

μ = planning horizon (years)

n = life of fixed assets (years)

$V_s^i(t)$ = $k(t)$, the cost of capital necessary to accommodate a new member of the club, using internal financing and self charging

$V_s^x(t)$ = the discounted (to time t) cost of capital necessary to accommodate a new member using external finance and self charging

$V_c^i(t)$ = same as above, but for internal finance and club charging

$V_c^x(t)$ = same as above, but for club charging with external finance

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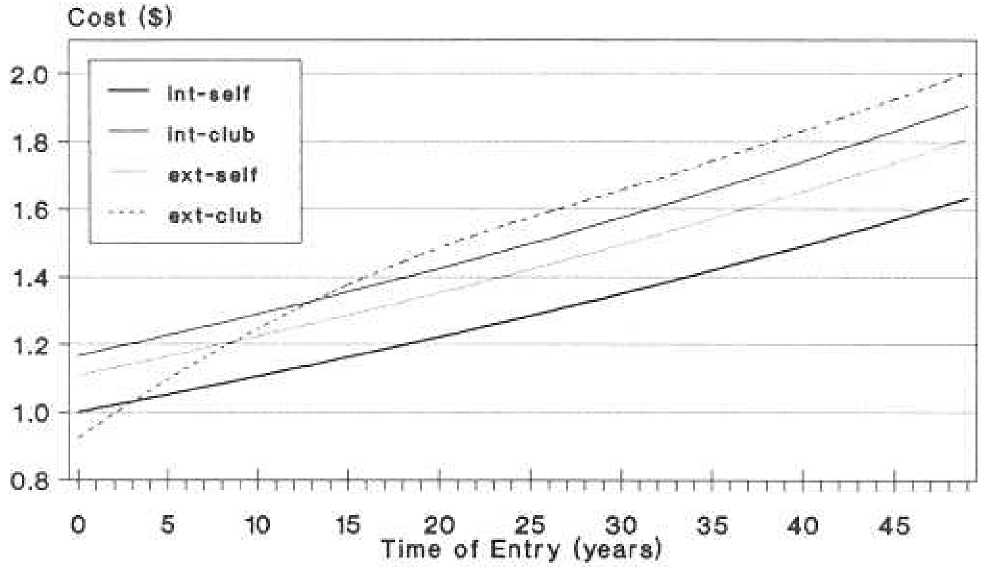
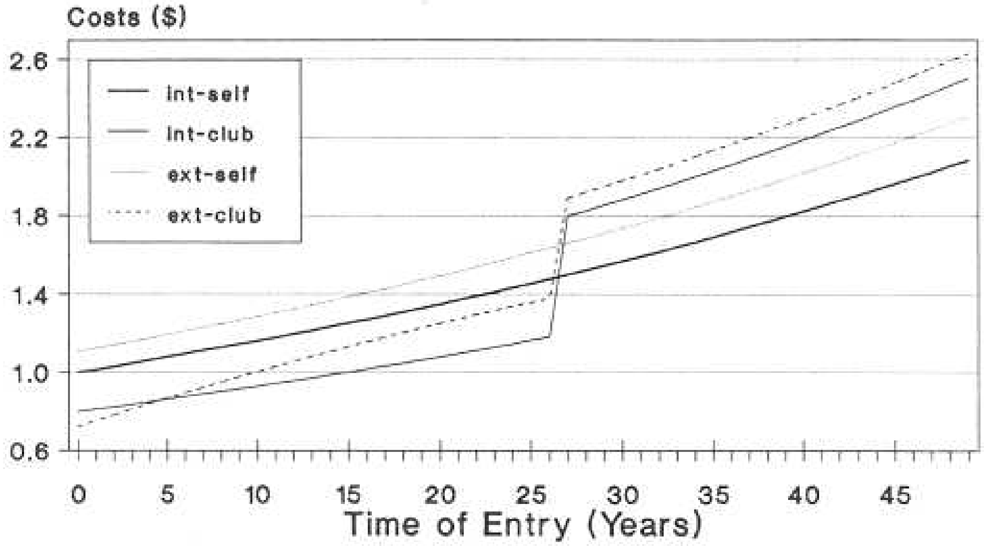
Fig. 1--Capital Costs
New-Entrant-Specific Costs
Per Dollar of Capital Required



Parameters: d = .05; ρ = .04;
c = 0.01; g = 0.035; m = 25 years.

Fig. 2--Capital Cost: Discontinuous g

New-Entrant-Specific Capital Costs
Per Dollar of Capital Required



Parameters: d =.05; ρ =.04; c =.015; m = 25. For $t < 30$, g =.02; for $t \geq 30$, g =.03.

Table 1

Discounted Capital Cost Equations

	Self Finance	Club Finance
Internal Funding	$V_s^i(t) = k(0)e^{ct}$ (1)	$V_c^i(t) = -\dfrac{k(0)e^{ct}g}{c-\rho}$ $(c-\rho < 0)$ (3)
External Funding	$V_s^x(t) = k(0)e^{ct}\dfrac{\phi(d)}{\phi(\rho)}$ (2)	For $t < m$: $(c-\rho < 0)$ $V_c^x(t)\Big\vert_{t<m} = \dfrac{k(0)ge^{\rho t}\phi(d)}{(c+g)}\left\{\left[\dfrac{e^{(c-\rho)m}-e^{(c-\rho)t}}{c-\rho} + \dfrac{e^{-(g+\rho)m}-e^{-(g+\rho)t}}{(g+\rho)}\right] - \dfrac{e^{(c-\rho)m}}{c-\rho}\dfrac{1}{\phi(c+g)}\right\}$ (7) For $t \geq m$: $(c-\rho < 0)$ $V_c^x(t)\Big\vert_{t\geq m} = -\dfrac{k(0)e^{ct}g}{c-\rho}\dfrac{\phi(d)}{\phi(c+g)}$ (5)

Note: $\phi(z) = z(1-e^{-zm})$, where the interest or growth rate z is compounded continuously and repayment occurs continuously over m periods.

Table 2. Pairwise Cost Comparison Conditions

1. $$D_s^{ix} = V_s^i - V_s^x = k(0)e^{ct}\left[1 - \frac{\phi(d)}{\phi(\rho)}\right] \gtreqless 0 \quad \text{as} \quad d \lesseqgtr \rho \quad (t \geq 0)$$

2. $$D_{sc}^{i} = V_s^i - V_c^i = k(0)e^{ct}\left[1 + \frac{g}{c-\rho}\right] \gtreqless 0 \quad \text{as} \quad \rho \gtreqless c+g \quad (t \geq 0)$$

3. $$D_{sc}^{x} = V_s^x - V_c^x = k(0)e^{ct}\phi(d)\left[\frac{1}{\phi(\rho)} + \frac{g}{c-\rho}\frac{1}{\phi(c+g)}\right] \gtreqless 0 \quad \text{as} \quad \rho \gtreqless c+g \quad (t \geq m)$$

4. $$D_c^{ix} = V_c^i - V_c^x = \frac{k(0)e^{ct}}{c-\rho}\left[\frac{\phi(d)}{\phi(c+g)} - 1\right] \gtreqless 0 \quad \text{as} \quad d \lesseqgtr c+g \quad (t \geq m)$$

5. $$D_{sc}^{ix} = V_s^i - V_c^x = k(0)e^{ct}\left[1 + \frac{g}{c-\rho}\frac{\phi(d)}{\phi(c+g)}\right] \gtreqless 0, \quad \text{as} \quad d \lesseqgtr c+g \lesseqgtr \rho \quad (t \geq m)$$
(see * below)

6. $$D_{sc}^{xi} = V_s^x - V_c^i = k(0)e^{ct}\left[\frac{\phi(d)}{\phi(\rho)} + \frac{g}{c-\rho}\right] \gtreqless 0, \quad \text{as} \quad d \gtreqless \rho \gtreqless c+g \quad (t \geq 0)$$
(see * below)

Notes: For (2), (3), (5) and (6), must have $c - \rho < 0$. The D's are derived from equations (1), (2), (3) and (5) in the text. $\phi(z)$ denotes the standard capital recovery factor $z/(1-e^{-zm})$, where the interest or growth rate z is continuously compounded and repayment occurs continuously over a period of m years. An * indicates sufficient but not necessary conditions.

Table 3

Present Value of Capital Costs Assigned to New Entrants Under Alternative Financing and Charging Modes

Capital growth rate (c)	ρ = .05				ρ = .04			
	V_s^i	V_s^x	V_c^i	V_c^x	V_s^i	V_s^x	V_c^i	V_c^x
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	d = .05							
(1) -.04	.30	.30	.10	.20	.30	.33	.11	.22
(2) -.03	.41	.41	.15	*	.41	.46	.17	*
(3) -.02	.55	.55	.24	.36	.55	.61	.27	.43
(4) .00	1.00	1.00	.60	.74	1.00	1.11	.75	.92
(5) .01	1.35	1.35	1.01	1.12	1.35	1.49	1.35	1.49
(6) .02	1.82	1.82	1.82	1.82	1.82	2.18	2.73	2.73
(7) .03	2.46	2.46	3.69	3.35	2.46	2.72	7.38	6.70
	d = .04							
(8) -.04	.30	.27	.10	.18	.30	.30	.11	.20
(9) -.03	.41	.36	.15	*	.41	.41	.17	*
(10) -.02	.55	.50	.24	.33	.55	.55	.27	.38
(11) .00	1.00	.90	.60	.67	1.00	1.00	.75	.83
(12) .01	1.35	1.22	1.01	1.01	1.35	1.35	1.35	1.35
(13) .02	1.82	1.64	1.82	1.64	1.82	1.82	2.73	2.47
(14) .03	2.46	2.22	3.69	3.02	2.46	2.46	7.38	6.05

*Undefined when c+g=0. See equation (7).
See "Notation" for definitions of variables. Entries computed from equations (1), (2), (3), and (7). All refer to year t=30, assuming g=.03 and m=25.

Table 4

Present Value of Differences in Capital Costs
Assigned to New Entrants
Under Alternative Financing and Charging Modes

Membership growth rate g		ρ = .05				ρ = .04			
		$V^i_s-V^i_c$	$V^x_s-V^x_c$	$V^i_s-V^x_c$	$V^x_s-V^i_c$	$V^i_s-V^i_c$	$V^x_s-V^x_c$	$V^i_s-V^x_c$	$V^x_s-V^i_c$
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		d = .05							
(1)	.01	1.21	.97	1.15	1.04	.91	.89	.70	1.11
(2)	.02	.61	.48	.48	.61	.0	.0	-.20	.20
(3)	.03	.0	.0	.0	.0	-.91	-.72	-.91	-.72
(4)	.04	-.61	-.38	-.38	-.61	-1.82	-1.29	-1.48	-1.63
(5)	.05	-1.21	-.62	-.45	-1.39	-2.73	-1.75	-1.95	-2.54
		d = .04							
(6)	.01	1.21	.97	1.15	1.04	.91	.81	.81	.91
(7)	.02	.61	.43	.61	.43	.0	.0	.0	.0
(8)	.03	.0	.18	.18	-.18	-.91	-.65	-.62	-.91
(9)	.04	-.61	-.35	-.17	-.78	-1.82	-1.16	-1.16	-1.82
(10)	.05	-1.21	-.62	-.45	-1.39	-2.73	-1.58	-1.58	-2.74

See "Notation" for definitions of the variables. Each entry represents the difference in present value costs between some self charging and some club charging regime as computed from equations in Table 2. All entries refer to year t=30, assuming c=.02 and m=25.