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Abstract:
With address to developing countries, this paper derives some formulae for the optimal price structure for publicly provided private goods. A general equilibrium model is examined, which makes it possible to incorporate features like distributional social objectives and public profit constraints in the analysis. The model identifies different sources which may cause the optimal public price structure to deviate from marginal cost pricing in a second-best optimum. The main result is that the optimal public price structure includes an implicit subsidy on commodities which are consumed relatively intensely by transfer-deserving households, whereas the same price structure involves an implicit tax on publicly provided luxuries.

Keywords: Equity, publicly provided private goods, income distribution.

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1. Introduction

The building blocks of social cost-benefit analysis have proved useful as a tool for welfare analysis in developing countries. Originally intended for single-project analysis, over the years a vast literature has developed, evaluating complex policy reforms when market prices are inappropriate measures of marginal social opportunity costs (e.g. Drèze and Stern [1990]). The traditional approach (see Dasgupta et al. [1972], Little and Mirrlees [1974]) aimed at providing estimates for the deviations between market prices and social opportunity costs of the project's various cost and income elements, using these estimates to construct shadow prices and marginal social opportunity costs. These measures were then applied to evaluate the social income and cost attached to the investment project under consideration. As optimal prices for public production are nothing but shadow prices at a second-best welfare optimum, the theoretical tools of cost-benefit analysis are closely related to those of public enterprise economics. The theory of the second-best has recognized that the government's control of the income distribution is often limited. Therefore, shadow prices should also be corrected according to their distributional impact (cf. Squire and Van der Tak [1975]). Over the years, important contributions have been made to incorporate special economic features to improve the theory of social cost-benefit analysis and optimal public pricing policies. Still, the scope for redistributive pricing has been somewhat neglected, an exception being Feldstein (1974a,b,c).

The general idea of this paper is that, at second-best optimum, the marginal social opportunity cost of any commodity should reflect not only compensated demand effects, but also the distributional impact of income effects from price changes. This aspect is often neglected, under the claim that public pricing policy is not the appropriate instrument for redistribution of income. This may be true if the public sector has access to lump-sum income transfers. With lump-sum transfers, the income effects from any change in the price structure may be neutralized by applying an optimal structure for lump-sum redistribution of income, according to the social preference ordering. In analyses meant for industrialized countries the income effects are probably also neglected under the excuse that potential redistribution of income represents a negligible threat to the general level of welfare. Consequently, a large part of the economic literature focusing on shadow prices and public sector pricing ignores the impact from the public price structure on the distribution of income, concentrating fully on efficiency matters (e.g. Hagen [1979]). Applying such methods in analyses of developing countries may be fatal. In developing countries, the distribution of income is typically far more unequal than in industrialized (and democratic) countries. In addition, the income level of low-income groups is often below the poverty line. This variation in income implies a larger scope for income redistribution, given the social preference ordering. Another crucial difference between industrialized and developing countries regards the capacity and efficiency of the public bureaucracy, in particular the tax administration authorities. The ability of industrialized countries to levy non-distortionary taxes is thus far more advanced than in the developing part of the world. In developing countries, lack of administrative capacity may exclude also many forms of indirect taxes, making an active public sector pricing strategy an important instrument, both for fiscal and distributional purposes.

Optimal prices for public production can be approached as shadow opportunity costs at second-best optimum. The theory of the second best and the techniques of cost-benefit analysis may therefore also be applied to evaluate the optimal price structure for the public production plan. This paper provides a formal illustration of the above ideas, the key premise being that the distributional impact of the public sector's pricing strategy should not be overlooked, especially not in analyses of developing countries. The reason is a conviction that the level of general welfare are more sensitive to marginal changes in the income distribution in developing countries than in industrialized countries. The formal framework is outlined in section 2. The implications of social distributional objectives and binding revenue-cost constraints for the optimal public price strategy is analyzed more closely in section 3. Some concluding remarks are offered in section 4.

2. The model

The aim of the following exposition is to relate the problem of optimal supply of public financial resources directly to that of optimal pricing of public production. The model is built in a general equilibrium setting, and may be thought of as a modified version of the Boiteux model (Boiteux [1956, 1971]).

A special characteristic of our model is that the social preference ordering embodies distributional objectives, resulting in optimal discount rates also reflecting the distributional impact of the public price plan (see Feldstein [1972a,b,c]). In addition, we allow for profits in the private sector. This feature allows a new source of marginal social effects of price changes. As price changes affect private profits directly, the optimal public pricing strategy should depend on the marginal social valuation of these changes in lump sum income for households.

Moreover, the producer of the public sector in our model is facing a binding *revenue-cost* constraint ($\bar{\Pi}^g$). This public profit constraint is bounded from below by break-even pricing, and from above by profit-maximizing behaviour. In practice, the public profit constraint may be a result of prices, qualities and a variety of other exogenous variables. However, the derivations below are restricted to the case where this revenue-cost constraint is exogenously fixed.

Three types of agents are included in the model. They are: H price-taking households and J competitive producers, and the public sector. The agents' time horizon is bounded from above, as the number of time periods is set to T. The number of goods is $N+1$, and good number 0 is treated as a numeraire ($p_0 = 1$). The public sector produces private goods in competition with the private producers, and controls a subset $\hat{p} \in p$ of the prices of private commodities. The government faces a restricted optimization problem, whereby welfare is maximized through appropriate policies.
But before we treat this optimization problem explicitly, the behaviour of each type of agent requires a brief introduction. Household h faces prices p, money income m^h, and the chosen net consumption plan is given by:

(2) $$x^h(p,m^h) = \frac{\partial v^h}{\partial p}(p,m^h)$$

where v^h is the indirect utility function, solving the utility maximization problem:

(3) $$v^h(p,m^h) = \max_{x^h} \left\{u^h = u^h(x^h,m^h) \mid p x^h = m^h\right\}$$

Direct utility is denoted by $u^h(x^h, m^h)$. Positive values for x_i are assigned to consumer goods, whereas negative values represent supply of consumer services, such as labour. Thus, the net consumption plan contains both positive and negative entries, and the direct price derivatives vary also by sign. Summation over all consumers yields:

$$x \equiv \sum_h x^h$$

The lump-sum money income of consumer h (m^h) is not completely exogenous, and has two sources. First, there is the lump-sum transfer r^h from the government, and second, there is lump-sum profit income for shareholders in private production, yielding for the total lump-sum income:

(4) $$m^h = r^h + \sum_j \theta^{jh} \Pi^j$$

where θ^{jh} represents household h's share in profits from firm j. The distribution of income depends in this way on the overall income of the share-holders in the private production activities. Profit maximization is the leading guide in private production. With notation corresponding to private consumption, the net production plan for firm j may be represented by:

(5) $$y^j(p) = \frac{\partial \Pi^j(p)}{\partial p}$$

where $\Pi^j(p)$ is a profit function solving the profit maximization problem:

(6) $$\Pi^j(p) = \max_{y^j} \left\{\Pi^j = p y^j \mid f^j(y^j) \leq 0\right\}$$

and y_j is the vector of inputs and outputs, and f^j is a net production function, characterizing the technology of firm j. The aggregate net supply plan is given by:

$$y \equiv \sum_j y^j$$

For market clearing to hold for all goods, we assume that public supply continuously adjusts to clear any excess demand. This implies that market clearing is secured, and the assumption may be stated as:

(6) $$\sum_h x^h(p, m^h) - \sum_j y^j(p) \equiv x - y = z$$

For efficiency in public production, the following equation must hold:

(7) $$g(z) = 0$$

where z is the net production plan of the public sector and where g may be thought of as some implicit production function. It is also assumed that the public sector is constrained by some form of exogenous income requirements. In principle, this may be positive or negative. The public sector's profit constraint ($\bar{\Pi}^g$) is considered exogenous, and we simply state the following for the public sector's restriction on profits:

(8) $$pz \geq \bar{\Pi}^g$$

For simplicity of exposition, let $v = (v^1, v^2, \ldots, v^h, \ldots, v^H)$ be defined as the vector describing all the consumers' indirect utility. Then assume that the government's preferences are represented by a general Bergson-Samuelson welfare function of the type:

(9) $$w = w(v)$$

Observe that this specification does not exclude preferences over income-distribution, although these are not explicitly formulated.

Without direct control of the income distribution, the public sector will have to consider also the distributional impact when choosing the optimal price strategy, an aspect that may well be analyzed within the described setting. With a public sector controlling a subset $\hat{p} \in p$ of the total set of prices, a constrained optimization problem can now be constructed, whereby the government maximizes the welfare function (9), given the constraints that individually secure market clearing, efficiency in public production, and fiscal constraints to be satisfied:

$$\max_{(\hat{p},\, r^h,\, z)} \; w = w(v) \tag{10}$$

subject to:

$$x - y = z$$

$$g(z) = 0$$

$$pz = \Pi^g$$

The first constraint simply states that all markets must clear, and it is assumed that public production adjusts to eliminate every excess demand. The second constraint is introduced to restrict the public sector to efficient production, whereas the third constraint says that budgets of the public firm has to equalize some exogenously fixed profit constraint. The variables under public control are the prices included in the vector $\hat{p}$, and the exogenous lump-sum income element r^h. These measures are set to maximize the social welfare function given the above constraints. The Lagrangian for the welfare-maximization problem in equation (10) may be formulated as:

$$L = w(v) - \alpha\left[x - y - z\right] - \beta\left[\, g(z)\,\right] - \gamma\left[\Pi^g - pz\right]$$

Shadow prices of the commodity-specific market-clearing conditions are given by α, shadow prices for the public profit constraint is represented by β, whereas γ is the shadow price of the profit constraint in the public sector. The first-order conditions are:

$$(15) \qquad \frac{\partial L}{\partial r^h} = \frac{\partial w}{\partial v^h}\frac{\partial v^h}{\partial m^h} - \sum_i \alpha_i \frac{\partial x_i^h}{\partial m^h} \equiv b^h = 0 \qquad h \in H$$

$$(16) \qquad \frac{\partial L}{\partial \hat{p}_k} = \sum_h \frac{\partial w}{\partial v^h}\frac{\partial v^h}{\partial \hat{p}_k^h} + \sum_h \sum_j \theta^{hj} b^h \frac{\partial \Pi^j}{\partial \hat{p}_k} - \sum_i \alpha_i \left[\sum_h \frac{\partial x_i^h}{\partial \hat{p}_k} - \sum_j \frac{\partial y_i^j}{\partial \hat{p}_k} \right] + \gamma z_k = 0 \qquad \hat{p}_k \in \hat{p}$$

$$(17) \qquad \frac{\partial L}{\partial z_i} = \alpha_i + \beta \frac{\partial g}{\partial z_i} - \gamma p_i = 0 \qquad i \in N$$

Equation (15) is the first-order condition for optimal lump-sum redistribution of income. This condition states that for each consumer the sum of all income effects should equal the marginal social valuation of these income effects. Thus, at a second best optimum, income effects has no distributional significance. The explanation behind this result lies in the access to lump-sum income transfers, allowing full concentration on *compensated* demand effects.

Equation (16) gives an optimal price structure, and social preferences for income equality are reflected through the first two terms on the left-hand side. The first term represents the direct effects upon consumption and household utility from a price change, whereas the second is working through the change in lump-sum profit income, following such changes.

Equation (17) is the condition for an efficient production plan in the public sector. With this system of tools we are ready to analyze some different aspects determining the optimal public price structure in an economy with social objectives regarding the distribution of income.

3. Optimal public pricing strategies

As argued in the introduction, distributional aspects are likely have a more important role in the social welfare function in developing countries than in the rest of the world. The implication is that distributional objectives deserve an corresponding role also in the general public pricing policy. The following exposition attempts to illustrate this idea in the technical framework presented above.

Feldstein (1972a,b,c) was one of the first economists to point out the inadequacy of the standard compensated Ramsey-Boiteux rules. Feldstein's work is concentrated on deriving rules for optimal price structures, taking explicitly account of the distributional impact of income effects.

To illustrate the main ideas, we assume that the public sector has no possibilities of redistributing income by means of lump-sum transfers. This implies that all the emerging demand effects will have to include income effects as well as substitution effects, leading us to speak in terms of *uncompensated* demand effects. In our model, excluding income distribution as a direct policy instrument means that the first set of first-order conditions is neglected, as equations (16) and (17) are the only ones that will have to hold. Substituting (17) into (16) yields:

(18)
$$\sum_h \frac{\partial w}{\partial v^h}\frac{\partial v^h}{\partial \hat{p}_k} + \sum_j \sum_h \theta^{hj} b^h \frac{\partial \Pi^j}{\partial \hat{p}_k} - \sum_i \left[\beta \frac{\partial g}{\partial z_i} + \gamma p_i\right]\left[\sum_h \frac{\partial x_i^h}{\partial \hat{p}_k} - \sum_j \frac{\partial y_i^j}{\partial \hat{p}_k}\right] + \gamma z_k = 0$$

To eliminate the dual variable β, we define:

(19)
$$\bar{\alpha}_i \equiv \frac{\alpha_i}{\beta g_0} \quad , \quad \bar{\gamma} \equiv \frac{\gamma}{\beta g_0}$$

where:

$$g_0 = \frac{\partial g}{\partial z_0}$$

$\bar{\alpha}_i$ is the normalized shadow-cost of commodity i, and $\bar{\gamma}$ is the normalized shadow-cost of the public profit-constraint. Using these definitions, and solving the normalized first-order condition from equation (17) yields for the numeraire :

$$\bar{\alpha}_0 + \bar{\gamma} = 1 \tag{21}$$

Since the shadow price of commodity 0 is positive at a constrained optimum, this implies that $\bar{\gamma} \in [0,1]$. This is an attractive property, and can be used to interpret the optimality conditions for the price structure in terms of weighted averages. The weights of these averages will depend on the shadow prices of the private producers and consumers, and of the public profit constraint. As $\bar{\gamma}$ is increasing in the exogenous profit constraint, it may be taken to reflect the public budgetary slack. For simplicity of exposition, and to facilitate a convenient interpretation of the first-order conditions we define:

$$\lambda^h \equiv \frac{\partial w}{\partial v^h}\frac{1}{\beta g_0} \tag{22}$$

as a normalized measure of marginal social welfare associated with an increase in income for consumer h. Thus, a government who is concerned about the distribution of income will choose a welfare function where λ^h is negatively correlated with the income and utility level. Taking into account that the marginal cost in public production public production of commodity i may be written[1]:

$$c_i^g \equiv \frac{g_i}{g_0} \tag{23}$$

The first-order conditions for an optimal price structure in the public sector may now be restated as:

$$\sum_i (c_i^g - \bar{\gamma} p_i)\left[\sum_h \frac{\partial x_i^h}{\partial \hat{p}_k} - \sum_j \frac{\partial y_i^j}{\partial \hat{p}_k}\right] = \bar{\gamma} z_k - \sum_h \left[\lambda^h \frac{\partial v^h}{\partial \hat{p}_k} + \sum_j \theta^{hj} \frac{\partial \Pi^j}{\partial \hat{p}_k}\right] \tag{24}$$

[1]If y_i is an input, c_i^g may be interpreted as the marginal rate of transformation.

Further simplification is achieved by adding $(1-\bar{\gamma})\Sigma_i p_i[\Sigma_h(\partial x_i^h/\partial\hat{p}_k) - \Sigma_j(\partial y_i^j/\partial\hat{p}_k)]$ on both sides of equation (23). Rearranging now allows an interpretation of the optimal price structure in terms of public price-cost differentials:

$$
\begin{aligned}
&\sum_i (c_i^g - p_i)\left[\sum_h \frac{\partial x_i^h}{\partial \hat{p}_k} - \sum_j \frac{\partial y_i^j}{\partial \hat{p}_k}\right] = \bar{\gamma} z_k + (1-\bar{\gamma})\sum_i \sum_j p_i \frac{\partial y_i^j}{\partial \hat{p}_k} \\
&\qquad - \sum_h \left[\lambda^h \frac{\partial v^h}{\partial \hat{p}_k} - (1-\bar{\gamma})\sum_i p_i \frac{\partial x_i^h}{\partial \hat{p}_k} + \sum_j \theta^{jh} \frac{\partial \Pi^j}{\partial \hat{p}_k}\right]
\end{aligned}
\tag{25}
$$

Equation (25) illustrates that the social opportunity cost public production at a second-best optimum depends on social preferences for income distribution, the marginal cost of public production, the public profit-constraint, and on repercussions through reallocation of resources in the private sector. This means that the social opportunity cost of commodities deviate from it's marginal cost of production whenever there are distributional objectives, price distortions in the private sector, or the public sector faces a binding profit constraint.

To simplify even further, we assume that the optimal public price plan secure that private producers act as if they were competitive price-takers operating under constant returns to scale. This assumption is possible even with market imperfections, because manipulation of product prices is equivalent to lump-sum taxes on private profits (cf. Diamond and Mirrlees [1976], Drèze and Stern [1987]). An optimal price structure in the public sector is therefore equivalent to an optimal lump sum tax structure on private profits. However, we implicitly assume that price-distortions are absent in sectors out of public control, or alternatively, that the public sector controls all prices. For an exhaustive analysis of the general case, see Hagen (1979), Bös (1989).

Recalling that y^j is the *net* supply plan of private producers, zero private profits must imply:

$$
\sum_i p_i \frac{\partial y_i^j}{\partial \hat{p}_k} = 0 \qquad \forall\ j
$$

This must be true by the homogeneity properties of the profit function, and the implication is that second term on the right-hand side of equation (24) vanishes. To focus explicitly on distributional aspects of the public pricing strategy, let us examine the last square-bracketed term of equation (24) somewhat more closely. The first terms in these brackets represent the social value of a marginal price change of commodity k for household h. Applying Roy's identity on this term gives:

$$\sum_h \lambda^h \frac{\partial v^h}{\partial \hat{p}_k} = \sum_h \lambda^h x_k \frac{\partial v^h}{\partial m^h}$$

Then, following Feldstein (1972a,b,c), and Bös (1989), we define a distributional characteristic as a weighted sum of household demand shares:

(25) $$\phi_k \equiv \sum_h \lambda^h \frac{\partial v^h}{\partial m^h} \frac{x_k^h}{x_k}$$

The social valuation of an increase in the supply of x_k is higher the higher is its share in the consumption by transfer deserving households. This idea is captured by ϕ_k.
Observe that the welfare weights of this distributional characteristic is decreasing in household income, as the marginal utility of money income for well-behaving households is negatively correlated with their share in total consumption expenditures. Further, the distributional characteristic of equation (25) will typically be higher for a necessity than for a luxury. Public pricing policies taking advantage of this kind of distributional characteristic is commonly referred to as *Feldstein pricing*, as Feldstein (1972a) was the first economist to introduce the concept of distributional characteristics in public sector pricing.

According to the Slutsky equations for private consumption demand it must be true for any change in the price structure:

$$\sum_i \sum_h p_i \frac{\partial x_i^h}{\partial \hat{p}_k} = \sum_i \sum_h p_i \left(\frac{\partial x_i^h}{\partial \hat{p}_k} \right)_{\bar{u}} - \sum_i \sum_h p_i x_k^h \frac{\partial x_i^h}{\partial m^h} = - \sum_h x_k^h$$

This property will be applied to reduce the second element of the square-bracketed term on the right-hand side of equation (35). This term may now be written $(1-\bar{\gamma})x_k$. Finally, we define:

$$\frac{\partial z_i}{\partial \hat{p}_k} \equiv \sum_h \frac{\partial x_i^h}{\partial \hat{p}_k} - \sum_j \frac{\partial y_i^j}{\partial \hat{p}_k}$$

as the uncompensated demand response for public production following a price change. Now we are ready to summarize the total social valuation of a marginal price change, including the distributional impact.

The optimality condition of equation (24) may now be written:

$$\text{(26)} \qquad \sum_i (p_i - c_i^g) \frac{\partial z_i}{\partial \hat{p}_k} = -(1 - \phi_k) x_k - \bar{\gamma}(z_k - x_k) - \sum_h \sum_j \theta^{hj} b^h y_k^j$$

Equation (26) represents the optimal pricing rule for the public sector, in the presence of competition with private producers, binding revenue-cost constraint, and social preferences over the distribution of income. The optimal pricing rule illustrates that deviations from marginal cost pricing in the public sector are defendable if the public sector is acting according to distributional objectives. Ignoring repercussions from private production, means that the two last terms on the right hand side of equation (26) cancel, and we are allowed to focus on the effects caused by the distributional social objectives:

$$\text{(27)} \qquad \sum_i (p_i - c_i^g) \frac{\partial z_i}{\partial \hat{p}_k} = -(1 - \phi_k) x_k$$

Observe first that for this special case, the optimal mark-up for public production will be positive for $0 < \phi_k < 1$, and negative for $\phi_k > 1$. This means that the public sector should employ its market power actively to generate extra profits from luxury goods. These profits should in turn cover the loss generated by negative mark-ups on goods that are consumed relatively intensely by transfer-deserving households. Accordingly, we see that if x_k is a luxury, the optimal mark-up is higher than in the monopoly case. On the other hand, if x_k is a necessity, the optimal mark-up is lower than marginal costs.

If the price-cost differentials are interpreted in terms of a set of tax rates, the analogy to standard optimal taxation rules of the Ramsey-rules becomes clear. To illuminate this point, it is possibly to derive an inverted elasticity rule also for the case of distributional pricing, although this rule is somewhat more complex than the standard Ramsey-rules. For the described case, the optimality condition in equation (26) implies:

$$\text{(28)} \qquad \sum_i \mu_i \eta_{ik} = -(1 - \phi_k)$$

where μ_i is the mark-up factor for commodity i:

$$\mu_i = \frac{p_i - c_i}{p_i}$$

and

$$\eta_{ik} = \frac{\partial z_i}{\partial \hat{p}_k} \frac{\hat{p}_k}{z_i}$$

is the set of uncompensated elasticities of excess demand for commodity *i*. It follows that the public sector in this case should act as a profit-maximizing monopolist, inflating all demand elasticities by the commodity-specific factor $1/(\phi_k - 1)$. This will generally imply a positive mark-up for luxuries and a negative mark-up for necessities. Equation (28) illustrates that there might well be situations where distributional aims dominate in the determination of the optimal public price plan. However, this result depends on the extent to which other measures can be applied for an improvement in the distribution of income. Accordingly, various types of shortcomings of the tax administration make this case especially interesting for developing countries.

The second and the last term on the right-hand side of equation (26) reflects effects caused by the interaction between private producers and the public sector. Hence, both these terms cancel in the case when goods with publicly controlled prices are neither demanded nor supplied by private producers. When interaction with private producers take place, the second term on the right side of equation (26) reflects the effects on the price structure from the public profit constraint. This effect applies only if there is competition with private producers in the supply of z_k.

Isolating the effect from the second term on the right-hand side of equation (26) implies for the optimal price-structure:

$$\sum_i (p_i - c_i^g) \frac{\partial z_i}{\partial \hat{p}_k} = - \bar{\gamma} (z_k - x_k)$$

Recalling from the market-clearing condition that $y_k = x_k - z_k$, the following elasticity rule may be derived:

$$\sum_i \mu_i \eta_{ik} = \bar{\gamma} \left(\frac{y_k}{z_k} \right) \tag{31}$$

In this case, deviations from marginal-cost-pricing take place not only because of distributional aims, but also because the profit constraint receives a more prominent place in the pricing rule, because of the competition between private producers and the public sector. Equation (31) illustrates how a large private sector reduces the possibility of sovereign public pricing policies, thus causing discipline in the exploitation of public market power. The effect is at its maximum absolute value if the public sector's profit constraint is binding ($\bar{\gamma} = 1$), and is reduced for any degree of public budget slack ($0 < \bar{\gamma} < 1$). An intuitive interpretation of this result is that competition between private producers and the public sector becomes more important, the more profitably the publicly provided goods can be priced. A high binding revenue-cost constraint means that the public sector may price its production far beyond marginal costs. This pattern is revealed in equation (31) by the effect from $\bar{\gamma}$, which is typically increasing in the magnitude of the public revenue-cost differential $\bar{\Pi}^g$.

The last term on the right-hand side of the optimal pricing rule in equation (26) reflects the repercussions from profits among private producers towards private consumption, as some consumers are engaged in productive activities, as stock-holders, entrepreneurs or peasants. With constant returns to scale, one may object that the production plan of any private firm breaks even at shadow prices, leaving zero profits (Diamond and Mirrless [1976]). However, this result also holds for positive profits in the private sector, provided that these profits are fully or optimally taxed. Our assumptions therefore imply that the optimal price structure of public production is equivalent to a set of lump-sum profit taxes, levied on private producers to make them behave as if they were operating under constant returns to scale. Isolating this private profits effect of equation (26) yields for the optimal price structure:

(32)
$$\sum_i (p_i - c_i^g) \frac{\partial z_i}{\partial \hat{p}_k} = -\sum_h \sum_j \theta^{hj} b^h y_k^j$$

Again, we may divide by z_k on both sides, to derive an elasticity rule also for this case:

(33)
$$\sum_i \mu_i \eta_{ik} = -\sum_j \left[\frac{b^j y_k^j}{z_k} \right]$$

where $b^j \equiv \sum_h b^h \theta^{hj}$ represents the social valuation of a marginal change in lump-sum taxation of profits in firm j. Equation (33) shows the impact on the public sector's pricing strategy in the case where income effects are generated because of repercussions to households from profits in the private sector. Further, this effect is equivalent to a lump-sum tax on private profits.

According to equations (26) and (33), the optimal pricing strategy of the public sector should therefore be influenced by the ownership structure in competing private firms. This effect will typically be influential for household production or for small-scale agriculture and industry, as these are activities often undertaken by so-called transfer-deserving households. On the other hand, the optimal price plan of equation (33) includes an implicit profit tax on firms mainly owned by high-income consumers. The third term on the right-hand side of equation (26) is closely related to the *net distributional characteristic* of Drèze and Stern (1987).

As the optimal discount rate for public investments is nothing but the marginal social opportunity cost of investment expenditure in the public sector, the pricing rule in equation (26) may also be interpreted as a rule for the socially optimal return on investments undertaken by the public sector.

First, equation (26) states that investment projects which, directly or indirectly, generate income for transfer-deserving households should be offered a lower price of capital services than projects favouring high-income groups. This in turn implies that projects benefitting low-income groups should be subject to milder cost-benefit tests than projects providing extra income for average- or high-income groups. In practice, the idea has relevance for public investments in the agricultural sector, public building society loans, and investment directed towards improvement in the infrastructure for transfer deserving households.

Second, if the government faces a binding budget constraint, the optimal pricing strategy involves a mark-up on the marginal social costs of capital services. Paying attention to profit constraints, and neglecting distributional aspects, will thus favour projects were high incomes tend to flow in over a few years, whereas long-term projects with a somewhat modest annual income more easily will be rejected.

For a given net present value, the optimal price plan for publicly provided capital services will favour projects where the surplus tend to descend over time to projects where the income profile rises over time. Thus, if public financial institutions reveal a myopic investment behaviour, this might be an optimal response to tight profit-constraints. This is highly relevant for developing countries, where common accusations against the governments have included impatience in the design of investment policies for low-income groups.

In the absence of preferences for income redistribution and public profit-constraints, the optimality condition of equation (26) simplifies to:

(34)
$$\sum_i (p_i - c_i^g) \frac{\partial z_i}{\partial \hat{p}_k} = 0$$

This implies that the public sector should price its production only for efficiency motives. However, an exogenously given discriminating tax system may cause divergence between consumer and producer prices. Before we conclude, the implications of such a tax system of the optimal pricing strategy will be offered a brief comment. This will illustrate how our model relates to alternative approaches to public sector pricing, where the tax system is take as exogenous (e. g. Sandmo and Drèze [1971]). Using the market-clearing condition, ignoring cross-elasticities, and restricting ourselves to the case with only one private producer, we may manipulate equation (34) to read:

$$c_i^g = p_i \left(\frac{\frac{\partial x_i}{\partial p_k}}{\frac{\partial z_i}{\partial p_k}} \right) + c_i \left(\frac{-\frac{\partial y_i}{\partial p_k}}{\frac{\partial z_i}{\partial p_k}} \right)$$

where c_k is the marginal cost of producing commodity y_k in the private sector. The bracketed expressions sum up to one, allowing us to state the optimal public pricing strategy as a weighted-average rule. Define:

$$\theta_i \equiv \left(\frac{\frac{\partial x_i}{\partial p_k}}{\frac{\partial z_i}{\partial p_k}} \right) \Rightarrow (1 - \theta_i) \equiv \left(-\frac{\frac{\partial y_i}{\partial p_k}}{\frac{\partial z_i}{\partial p_k}} \right)$$

With perfectly competitive markets, the consumers will face prices equal to their marginal rates of substitution (MRS_{i0}), and the marginal cost of private production will reflect the marginal rate of transformation (MRT_{i0}). This implies that the optimal public pricing strategy is represented by a weighted average, involving the marginal valuation of the commodity among consumers and producers, as equation (34) now implies:

(36) $$c_i^g = \theta_i MRS_{i0} + (1 - \theta_i) MRT_{i0}$$

More generally, with discriminating taxes, the optimal price of the public good is give as a weighted average between consumer prices and producer prices. Through public production activities, resources are displaced from consumption and private production. The weights of the pricing rule in equation (36) reflects the allocation of these crowding-out effects from public production activities. If all resources are displace from private consumption, $\theta_i = 0$, and for the case that private production could replace all public production activities, $\theta_i = 1$. Observe also that a non-distortionary tax system would secure the equalization of marginal rates of substitution to the marginal rate of transformation. In this case, the optimal public price would equal private marginal costs. The pricing rule of equation (36) is also equivalent to the optimal public discount rate rules demonstrated in a related intertemporal framework by Sandmo and Dréze (1972).

4. Concluding remarks

Our technical discussion has provided us with a set of second-best policy rules, in which the public price structure in general depends on the social valuation of private consumption. Thus, optimal public pricing policy involves an implicit subsidy on commodities which are consumed relatively intensely by transfer-deserving households. Thus, necessities provided by the public sector should be priced below marginal costs. On the other hand, the same strategy includes an implicit tax on commodities which are consumed mainly by high-income households, relatively speaking. This means that publicly provided luxuries should be priced above marginal cost pricing.

The efficiency of the pricing policy depends the extent of competition between the public sector and private producers in the actual markets. If the public sector is a monopolist, full attention may be payed to the redistributive policies. With private producers, the public sector commitment to redistributive pricing is falling in the private sector's market share. The ownership of private firms may also be of relevance for the optimal public pricing strategy, as the marginal social value of price changes depends on the social valuation of marginal changes in private profits. If private firms are owned by transfer-deserving households, the marginal social valuation of profits is higher than if private production is run by high-income households.

Most developing countries are plagued by severe income inequality. For a given set of social preferences, this makes the need for policies to redistribute income far more urgent in developing countries than in the industrialized world. At the same time, the ability of the public administration in developing countries to levy non-distortionary taxes is clearly insufficient. This situation gives the public pricing policy a prominent role for income redistribution. This paper has offered a technical discussion of the ideas within the framework of a slightly modified general equilibrium model. The model provides second-best rules for public pricing policy which are in consonance with the ideas stated in the introduction. Thus, there are cases when the public sector should use its market power actively in the purpose of redistributing income. Moreover, these situations are likely to be more frequent in developing countries than in the industrialized part of the world.

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