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Contrasting approaches to the 'problem' of cross subsidy

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The definition and measurement of cross subsidy, which has emerged as an issue in utility regulation, is one of management accounting's most pronounced interfaces with public policy. Analytical clarity is essential, particularly because this is a context in which language is used both imprecisely and persuasively. Benchmarks from which cross subsidies are to be measured must be defined. Two contrasting approaches are identified: the first starts from cost allocation and the second from optimal pricing. Whereas cost-based theoretical tests for cross subsidy are typically defined in terms of Stand Alone Cost and Incremental Cost, most regulatory discussion and empirical work resorts to various forms of Fully Distributed Cost. However, the economic literature on public and regulated industry pricing insists upon the primacy of pricing, denying that cross subsidy can sensibly be measured exclusively in terms of cost. Whilst market liberalization and denationalization will lead to the elimination of socially motivated cross subsidy, other than that imposed by regulation, more aggressively profit-seeking enterprises will view the predatory use of cross subsidy as a tool of commercial policy. The discussion of cross subsidy in a regulatory context constitutes a highly convenient vehicle for raising issues of much broader relevance to management accounting research and practice.

Key words: cross subsidy; public utility regulation; cost allocation.

1. Introduction

As a consequence of the U.K. privatization programme of the 1980s and early 1990s, there has been a rapid growth of the U.K. literature on utility regulation. Economists and public administration specialists have been much more active in this field than academic accountants though almost all the data generation—whether for financial reporting, cost allocation or price capping—is done by practising accountants and management consultants with an accountancy background. The definition and measurement of cross subsidy has emerged as a pivotal regulatory issue.

Most of the examples used in this article come from public utility sectors, though many of the issues to be addressed are relevant in other contexts: for example, alleged predatory pricing in the U.K. newspaper industry was a highly charged issue of public debate in the summer of 1994. Utilities tend to exhibit cross subsidy in a

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more extreme fashion than other sectors of the economy: moreover, the documents published by both the Monopolies and Mergers Commission (Lipworth, 1993) and the sectoral regulatory offices provide data which elsewhere are treated as 'commercial in confidence', and thus are not in the public domain. This material therefore constitutes a highly convenient vehicle for raising issues of much broader relevance to management accounting research and practice.

The article is structured in the following way. Section 2 provides a preliminary discussion of what is meant by claims that particular cases exhibit cross subsidy. Section 3 discusses the basis of cost measurement. Then, the two principal approaches to cross subsidy definition and measurement are analysed. Section 4 considers approaches based on cost allocation whilst Section 5 considers those based on optimal pricing. Section 6 demonstrates the policy relevance of these theoretical approaches, taking examples from utility sectors. Finally, Section 7 draws conclusions about public policy approaches to the 'problem' of cross subsidy.

2. What are cross subsidies?

Symmetrically, cross subsidies are hard to measure because they are hard to define, and hard to define because they are hard to measure. Moreover, the topic of cross subsidy is an excellent example of a context where language is used both imprecisely and persuasively. Some consumers are said to be paying 'too little' for some goods, at the expense of other consumers who are paying 'too much'.

Claims that particular cases exhibit cross subsidy can usually be traced to one or both of two sources:

> (a) the existence of costs common[1] to more than one output, so that there is enormous scope for argument as to how such common costs should be allocated to outputs; or
>
> (b) the existence of monopoly power which may be due entirely to economic factors (economies of scale and scope and the strength and pattern of demand) or entirely to political factors (the granting of legally enforceable exclusive rights to supply), or to some combination of these. Under these circumstances, cross subsidy may extend far beyond the treatment of common costs to embrace the entire relationship between costs and prices.

Claims that there is cross subsidy should not necessarily be accepted at face value: they will customarily be intended to elicit public policy responses, whether to make market forces more effective (by taking action to stop anti-competitive behaviour) or to overrule them (by substituting administrative or judicial judgements for market processes).

Ambiguity stems from the virtual impossibilty of constructing unequivocal and uncontested benchmarks for the purpose of determining whether there is cross subsidy in particular cases. Two approaches can be identified: in the first, cross subsidy is measured with reference to benchmarks which are generated through a

[1] A distinction is usually drawn in the management accounting literature between joint costs (two outputs are of necessity produced together) and common costs (the same input is used in the production of several outputs). However, following the policy literature, this article uses common costs to cover both, since the distinction does not materially affect the argument. Both are sufficient conditions, but neither are necessary conditions, for there to be claims about cross subsidy based on (a).

process of cost allocation; and, in the second, it is measured with reference to benchmarks which are defined by optimal pricing rules established within the economist's framework of social welfare maximization. In the case of the first, there is the difficulty that the so-called cost benchmarks are sometimes themselves 'hybrids' affected by demand: it was one of Hotelling's (1925) seminal insights that demand-side considerations influence, *inter alia,* depreciation allocations. The application of game theory leads to exactly the same conclusion about common cost allocations, namely that demand matters (Sharkey, 1982). Elaborate cost allocation exercises—especially when they proceed independently of demand—have weak conceptual underpinnings which cannot support the weight attached to them. The use made of the resulting accounting numbers may offend economic sense, notably in prohibiting pricing structures (e.g. peak load pricing) which can be shown to be economically efficient (Bös, 1985; Burns, 1992). Moreover, such exercises entail substantial procedural interventions in markets by public regulators and run the risk that the level of co-operation amongst market participants necessary to make such arrangements work may spill over into anti-competitive behaviour. On the second approach—when cross subsidies are measured from benchmarks defined in terms of optimal pricing structures—the equally intractable pricing problem (requiring knowledge of demand elasticities as well as the measurement of marginal costs) has to be 'solved' before the cross subsidy issue can be addressed.

In light of the complexity of these matters, it remains useful to contrast approaches to cross subsidization which start from a cost benchmark—even though this in reality may be a hybrid—and optimal pricing approaches which explicitly depend upon both cost functions and demand conditions.

3. Cost measurement

Before embarking upon a discussion of cost allocation, it is appropriate to note that controversies about cross subsidy raise fundamental issues about cost measurement. Cost is differentiated from cash flow by the use of accruals techniques. Cost can be measured on an Historic Cost (HC) or Current Cost (CCA) basis, a distinction to which special importance attaches in sectors which exhibit both high capital intensity and long asset lives. Costs can be measured in the short-run and in the long-run, with the possibility arising of large differences when there is high capital intensity, long asset lives and a serious imbalance between the actual and desired capital stock. Cost measurement can be approached either through the detailed tracking of costs (through accounting records) or by means of modelling the production system (often using linear or non-linear programming techniques). There is the distinction between the accounting costs used in financial reporting and the opportunity costs relevant to management decision-making. Moreover, the discussion in Section 4 below emphasizes that (what are measured as) the firm's costs may themselves by affected by the demand conditions faced by that firm.

4. Cost allocation approaches to cross subsidy

There are two sets of reasons for embarking upon cost allocation procedures[2] given the inevitable difficulties and expense that these entail:

[2] The clash between 'anti-allocationist' and 'allocationist' views in the accounting literature is illustrated by Thomas (1969, 1982) and Burrows (1994).

(1) in order to provide information which aids managerial decision-making; and
(2) in order to comply with externally imposed requirements: the three most significant are those imposed upon multinational companies by tax authorities to protect the integrity of their jurisdiction's revenue base; those required under joint venture arrangements; and those imposed by competition authorities including sectoral regulatory agencies.

These differences of purpose have important implications. The optimal decision rule in terms of (1) is to equate the marginal benefit of more decision-relevant information to the marginal cost of information generation. For the purposes of (2), compliance costs should be minimized when cost reporting requirements are genuinely exogenously determined. When they are not, information on the structure of compliance costs needs to be fed back into the design of reporting requirements.

Alternative cost benchmarks

There are three general approaches to the problem of cost allocation: Fully Distributed Cost (FDC), Stand Alone Cost (SAC) and Incremental Cost (IC). These are now discussed in turn.

Fully Distributed Cost (*FDC*), alternatively known as Fully Allocated Cost, involves the adoption of systematic procedures through which all costs, including common costs, are allocated to particular outputs. FDC subsumes different procedures producing widely different results; any illusion of uniqueness has to be quashed (Ahmed and Scapens, 1991). What enables FDC to be described as a single method is solely that all costs must be allocated to outputs, whatever the proportion of common costs and the elusiveness of cost drivers. Within accounting practice, there are three well-established algorithms (direct, step-down and reciprocal), discussed here in increasing order of sophistication and complexity. Under the direct algorithm, costs are allocated from service departments to production departments, there being no allocations between service departments. Under the step-down algorithm, costs are allocated from service departments to both production and service departments. When the costs of a particular service department have been fully allocated, that service department drops out of the process in the sense that its utilization of those service departments which are dealt with at a later step is disregarded. Unsurprisingly, the sequence in which service departments are excluded can significantly affect the results of the cost allocation exercise. Under the reciprocal method, a simultaneous equation model is constructed, the solution to which gives the total overhead recharges for each production department. Whilst the simultaneous equation algorithm is the most intellectually defensible, it is damaged by the fact that there is no cumulative calculation of a department's overhead charge, making it more difficult to win acceptance of such a system. The greater transparency of the conceptually inferior step-down algorithm, revealing overhead allocation at each step, is an important factor in its durability.

When a huge proportion of costs are fixed, possibly sunk, it is often difficult to find convincing bases for overhead cost allocation. However, there is an important opposing factor. It is a common observation in the management accounting literature (Yoshikawa *et al.,* 1993; Horngren *et al.,* 1994) that the conventional bases of overhead cost allocation (traditionally, labour hours and machine hours)

have been severely eroded by technological and organizational change. What have traditionally been regarded as overhead costs to be apportioned on some 'arbitrary' basis have been a mixture of common costs and direct costs for which tracking of use was either too difficult or too costly. Remarkable advances in metering technology, in terms of both feasibility and cost, have enormously extended cost-tracking possibilities. Therefore, it is now often possible to strip out these hidden direct costs and charge them to cost centres on a measured use basis, rather than apportion them in a broad-brush way. In conjunction with both direct measurement and usage-based recharging, the overheads which are left to be recharged on difficult-to-defend bases can be substantially reduced. Technology has thus affected common costs in two contrasting ways, increasing the proportion of common costs whilst creating new possibilities of direct allocation of many non-common costs hitherto treated as if they were common costs.

Activity Based Costing (ABC) (Cooper and Kaplan, 1988; Yoshikawa *et al.*, 1993) should be interpreted as a more sophisticated means of implementing FDC, not as a departure from FDC. Its advantages stem from the refocusing away from overhead allocation bases such as direct labour or machine hours towards the cost drivers behind activity cost pools, and from its emphasis upon specifying the hierarchy of activities, outputs and costs (Cooper, 1990). Costs which are joint or common at one level are not necessarily so at a higher level; thus, though it may be impossible to separate out the costs of two outputs, it may be perfectly feasible to separate their total costs from the costs of other outputs.[3]

Stand Alone Cost (*SAC*) redefines the problem, away from allocating the accounting costs which have been incurred, to one of determining the hypothetical cost of producing each output in isolation from the other outputs and relating these to the prices charged for the output. An output j is *not* the *source* of cross subsidy if $p_j \leq (\mathrm{SAC})_j$. Four issues customarily arise in this connection:

(1) implementation of an SAC approach requires knowledge not only of the cost function of the existing technology but also of the cost functions of alternative technologies;

(2) the information requirements (about alternative technologies and relative costs) are likely to be very high, especially in contexts such as telecommunications where there are rapid changes in technology and, hence, in costs;

(3) asymmetric information is likely to be a major problem: the incumbent firm's knowledge about the costs of existing production processes is likely to be superior to that of either the regulator or potential entrants, whilst the

[3] However complex game-theoretic algorithms for cost allocation become, they are essentially a method of operationalizing FDC, sometimes IC. Most of the empirical literature on cost allocation appears, not in accounting journals, but in sectorally oriented or operations research journals: for example, Baxendale (1987) on defence; Verbruggen (1983) on electricity; Shaffer (1984) on financial services; Klein (1993) on gas; Possai and Goetz (1994) on hospitals; Mjelde *et al.* (1985) on offshore engineering; Encaoua and Moreaux (1987) on telecommunications; Felton (1980), Hendrickson and Kane (1983), Hoffer (1983), Samet *et al.* (1984), Fowkes *et al.* (1985) and Fujii (1989) on transport; and Young *et al.* (1982), Driessen and Tijs (1985) and El-Nashar (1989) on water. Unfortunately, the behavioural dimensions of the accounting context and the practicalities of generating the necessary accounting data typically receive little attention. Although Young (1985*a*) focused on internal incentives to efficiency within the firm, Young (1985*b*, p. vii) stressed that 'cost allocation is thus ultimately concerned with fairness'.

potential entrant may have superior knowledge about the costs of alternative technologies; and

(4) because the cost of each output is evaluated in terms of the hypothetical costs of producing each separately using the currently best available technologies, it is easy to envisage two cases at opposite ends of a spectrum:

(a) when technology is unchanging and economies of scale and scope are very strong, SAC for each activity may be very high, thereby conferring enormous pricing discretion upon the incumbent which could be used to generate monopoly profits and to prevent competition in (potentially competitive) adjacent markets; and

(b) when technology is rapidly changing—in such a way that drastically reduces SAC for a subset of activities—and the incumbent multi-product firm experiences weakening economies of scope but still has high sunk costs, then the incumbent may not be able—in the absence of statutory protection against competition—to cover its accounting costs.

The concept of SAC is deeply rooted in the theory of the multi-product firm within which the ideas of contestability (ease of entry and exit) and sustainability (ability of an incumbent natural monopoly to resist entry) play central roles. The modern definition of a natural monopoly is that least-cost supply is by a single firm. A natural monopoly is sustainable if an incumbent is able to find a vector of output prices which prevents 'inefficient' entry (inefficient because entry would destroy the optimal industry structure of single-firm supply) (Baumol *et al.*, 1982; Waterson, 1988). The efficiency benchmark is that of contestable markets, in which—whatever the number of firms in the market—the absence of barriers to entry and exit means that potential competition can discipline the behaviour of incumbent firms. When entry and exit are costless, a sustainable natural monopoly will choose a vector of output prices which involves no cross subsidy; these are 'subsidy-free' prices (Faulhaber, 1975).[4] This is an ideal world, in which market forces discipline incumbent firms whatever their number—even a natural monopoly; barriers to entry and exit may destroy this idyll.

Incremental Cost (*IC*) is defined as the increase in cost associated with producing a 'second' output in addition to a 'first' output.[5] From this perspective, a second

[4] Brown and Sibley (1986, pp. 2–3) summarized the case for SAC, in the following way: 'When rate changes of a sweeping nature are proposed in a rate hearing, it is common for users facing increased prices to argue that under the new rates they would be subsidizing other users and, therefore, that the rate increases should be disallowed. In cases where the utility faces a fringe of competitive suppliers, these suppliers commonly allege that the utility is unfairly competing against them by means of predatory prices financed by cross subsidies from other areas of the utility's business. During this kind of debate it is common for the opposing parties to advance widely differing definitions of cross subsidy and to propose different tests for its existence. Typically, regulatory bodies choose some form of Fully Distributed Cost (FDC) standard to test for cross subsidy. Beginning in the 1970s economists began to formulate a more careful theory of cross subsidy. Under this theory, a cross subsidy is said to exist where there is an incentive for one or more groups of customers of a public utility to desert the public utility and choose to be served by a firm catering to their demands, on a stand-alone basis. A subsidy-free set of prices is one such that no group of customers is paying more than its stand-alone cost and the regulated firm covers all its fixed costs. An equivalent statement is that the regulated firm break even with each customer group paying at least the incremental cost of serving it. In this framework, economists have shown that FDC cost standards have no meaning as tests for cross subsidy'.

[5] The measurement of IC receives further discussion in Section 5 in the context of the implementation of marginal cost pricing.

output which at least covers its incremental costs is not the recipient of a cross subsidy from the first output: an output j is *not* the *recipient* of cross subsidy if $p_j \geq (\mathrm{IC})_j$. A second output which less than covers its incremental cost is the recipient of such a cross subsidy. It may matter crucially which output is defined as 'first' and which as 'second' because the first must carry all the common costs. If the output defined as first is monopolized, this multi-product firm may establish dominance in an adjacent market, even one which might otherwise be highly competitive. There is *a priori* no limit to the number of outputs which may have to be considered, thus raising the issue of ordering.[6] It may be impractical to evaluate all the possible orderings.

Moreover, the introduction of demand-side considerations may bring further complications. On a gross incremental cost basis, one output may clearly be financially supported from the profits of another activity. Nevertheless, the seemingly obvious conclusion that this is a case of cross subsidy may have to be qualified or retracted if there are interactions on the demand side which mean that below-cost supply of Y_2 leads directly to a more than compensating increase in the profitability of Y_1.[7] IC measures may therefore be exclusively cost-based (gross incremental cost) or adjusted for the demand-side repercussions of supply-side configurations (net incremental cost). This modification from gross to net massively complicates the process of evaluating arguments about whether cross subsidy occurs, because it introduces a requirement for information about cross price elasticities of demand which is typically not available.

Furthermore, there can be an important asymmetry between output expansion and output contraction. Whereas IC refers to expansion (producing one more output), Avoidable Cost refers to contraction (producing one less output). Although the two concepts are obviously closely related, the existence of long-lived assets which constitute sunk costs can lead to marked differences between the two in public utility sectors.

A test for cross subsidy

An output j is the *source* of cross subsidy if $p_j > (\mathrm{SAC})_j$, and is the *recipient* of cross subsidy if $p_j < (\mathrm{IC})_j$. An output j is *neither* the *source* of, *nor* the *recipient* of, cross subsidy when

$$(\mathrm{IC})_j \leq p_j \leq (\mathrm{SAC})_j.$$

There is no cross subsidy when the price of an output j is greater than or equal to its IC *and* less than or equal to its SAC. This equation requires to be generalized in terms of revenues so that the test is performed not just for individual outputs but also for all combinations of outputs. For all subsets S of the set of all outputs

$$(\mathrm{IC})(y_S) \leq \sum_{j \in S} p_j y_j \leq (\mathrm{SAC})(y_S)$$

where $y_S = (y_j)_{j \in S}$.

[6] This issue has received much theoretical attention: Shapley prices are incremental costs averaged over all possible orderings of outputs whilst Aumann-Shapley prices are marginal costs averaged over a linear path from zero to current production (Curien, 1991, p. 82).

[7] A practical example *might* be the free supply of Minitel terminals (Y_2) by France Telecom if that led to highly profitable incremental growth in the use of the telecommunications network (Y_1).

It is therefore possible that a particular output, which 'passes' the cross subsidy test when that is performed for that output alone, forms part of a combination of outputs which fails the test when it is performed for the combination. Naturally, this requirement to test combinations greatly complicates operationalization. Irrespective of 'level', the test produces three possible 'verdicts': source (tested with reference to SAC); recipient (tested with reference to IC); and neither source nor recipient (tested with reference to both).

This test for cross subsidy is grounded in the theories of contestable markets and of natural monopoly. Sustainability requires that:[8]

$$\sum_{j \in S} p_j y_j \leq (\text{SAC})(y_S).$$

If this SAC test cannot be passed, then 'the set of services comprising S is in a significant sense subsidizing the remaining set of the firm's products' (Faulhaber, 1975; Faulhaber and Levinson, 1981; Baumol *et al.*, 1982, p. 352). A complicating factor is that, due to the cost synergies which give rise to economies of scope, origins and destinations of cross subsidy do not necessarily sum to zero (Curien, 1991). Although measurement is likely to be difficult, an important insight is that floors (IC) and ceilings (SAC) can be set to 'legitimate' prices (Cave and Mills, 1992, p. 28).

Commentary

In terms of the literature and practice, it is tempting to characterize FDC as an accountant's method; SAC as an economist's method; and IC as shared ground. For reasons entirely comprehensible in the light of their differing interests and methods, accountants usually focus upon actual transactions whereas economists are much more ready to work in terms of the hypothetical and counterfactual. FDC can be measured from accounting systems, which can also generate estimates of IC provided that there are replacement cost data. In contrast, SAC will certainly have to be estimated outside the accounting system, often using less than ideal data. Whereas accountants naturally stress verifiability, decision-relevance weighs more heavily with economists, who suspect that FDC systems are a breeding ground for cross subsidies (Brennan, 1990).[9] FDC systems normally concentrate upon the allocation of accounting costs which have been incurred (though there may be some substitution of opportunity for historic costs); they are 'here and now' systems. IC systems can allocate *either* accounting costs *or* economic costs. There have been several attempts to place the measurement of accounting costs on an overtly economic basis (Byatt, 1986), notably the attempt to institutionalize inflation accounting. Although inflation accounting in the U.K. collapsed spectacularly in

[8] The sum of the revenues from any subset S of a sustainable natural monopolist's outputs must be less than, or equal to, the SAC of that subset. Otherwise there will be incentives for entry.

[9] '[Economists] particularly single out the fact that different FDC allocation methods are essentially arbitrary, yet can lead to widely different results. Second, there is no effort in FDC pricing to increase economic efficiency; the important cost concept is not marginal cost, but an 'average cost' with no clear rationale. Also, price elasticities of demand have no place in setting FDC rates, except perhaps in forecasting revenue so FDC prices will generally be much different from Ramsey prices. Finally, economists have argued that FDC methods are utterly meaningless in one of their main uses, testing for cross subsidy. *Cross subsidy, logically, should exist only when the deletion of a service benefits users of other services* [i.e. not covering net incremental cost]' (Brown and Sibley, 1986, p. 49, italics added).

the mid-1980s, the Government's choice of sectoral regulators[10] for privatized utilities kept this issue on the regulatory agenda, most notably through requirements to prepare regulatory accounts on a CCA basis.

The academic literature on cost allocation is overwhelmingly normative in design and prescriptive in its conclusions. How to allocate common costs is an intellectually fascinating problem, in answer to which it is possible to engage in sophisticated modelling and mathematical analysis. Perhaps the fundamental question to be asked about these solution algorithms relates to why decision-makers should find compelling the particular value judgements which underpin particular solutions. The algorithms, however elegant, often have little in terms of behavioural or motivational underpinnings. Moreover, as cost allocation schemes affect the economic interests of those implementing or canvassing particular solutions, they are likely to adopt a menu approach to the choice of procedures and algorithms, thus favouring on supposedly technical grounds those which have in reality been favoured on grounds of self-interest. Even after years of academic and regulatory discussions about cross subsidies in U.S. telecommunications, there remain disagreements about who subsidized whom and and by how much.[11] Cost allocation, particularly when perceived to be relevant to cross subsidy and/or predatory pricing, is not performed behind a veil of ignorance which denies participants knowledge of how the resolution of technical matters affects their interests. Debates about cross subsidy are characteristically conducted in a climate of advocacy.

Considerations of fairness are sometimes evoked in the context of cost allocation exercises, with appeal being made to perceived 'ability to pay'. The danger of such an approach is that it confuses the issue, mixing up the question of whether there are cross subsidies with the question of whether a certain pattern of cross subsidies is desirable or acceptable. Introducing fairness at the cost allocation stage seriously erodes the transparency of the process, precisely when transparency has become more important due to the widely divergent concepts of fairness which have advocates.

5. Optimal pricing approaches to cross subsidy

There is a sophisticated theoretical literature on optimal pricing policies for public and regulated enterprises (Rees, 1984*a*; Bös, 1985, 1986; Wilson, 1993). Much of that theory relates to the development of the optimality conditions for marginal cost pricing and for Ramsey pricing (where the enterprise must respect a break-even constraint and marginal cost pricing would generate losses). The objective function is welfare maximization, interpreted as the sum of producer and consumer

[10] Of the four inaugural U.K. regulators for privatized telecommunications, gas, electricity and water, two—Mr Ian Byatt at OFWAT and Professor Sir Bryan Carsberg at OFTEL—have longstanding commitments to inflation accounting, both having been members of the Byatt Committee (Byatt, 1986).

[11] 'Those who do not understand history are condemned to repeat it. The current discussion of cross subsidies by the RBOCs [Regional Bell Operating Companies] threatens to reiterate all of the confusion of pre-divestiture discussions of AT&T's presumed cross subsidies. More careful analysis of current conditions reveals that the RBOC's competitive activities are *not* being cross subsidized out of the local base rate. If they are being subsidized, the subsidies come from the IX [inter-exchange] carriers' (Temin, 1990, p. 349).

surpluses. In much of the analysis there has been relatively little concern as to *why* decision-makers can be assumed to maximize social welfare rather than some non-altruistic variable.[12]

In the development of optimal pricing rules, efficiency considerations are typically assumed to be paramount. However, this need not necessarily be the case. Marchand *et al.* (1984) analysed five models:

(1) the standard model in which efficiency is the sole concern and which demonstrates the optimality of marginal cost pricing;
(2) the familiar extended model in which the first-best marginal cost pricing rules must be modified to prevent financial deficits: when cross elasticities of demand are zero, the Ramsey conditions simplify to the inverse elasticity rule;[13]
(3) where income distributional weights are built into the formal analysis;
(4) where the existence of macroeconomic imbalance and extensive unemployment leads to the incorporation of a shadow price of labour into the formal analysis; and
(5) where all three modifications to the standard analysis are made simultaneously.

The optimal pricing policies which are derived from such models depend crucially upon the assumptions which have been built into them.

Where an industry is a sustainable natural monopoly reinforced by statutory protection from competition, there exists enormous discretion to incorporate distributional weights and macro-derived shadow prices of labour and foreign exchange into the analysis. The results of model (5) might be expected to incorporate extensive interpersonal and territorial cross subsidy. Provided that this is optimally designed, cross subsidy would be regarded as a legitimate instrument of public policy (Feldstein, 1972). However, after eliminating statutory protection from competition and dropping the prior assumption of sustainability, Ramsey pricing cannot be assumed to be sustainable against entry. Market liberalization—as is often explicitly intended—dramatically reduces the pricing freedom of incumbents which underpins models (3), (4) and (5).

Within this framework, cross subsidy is defined in terms of deviations from optimal prices, as derived from the efficiency-driven models (1) or (2). Those models incorporating distributional weights and shadow prices will have cross subsidy built into optimal prices. However, these definitions of cross subsidy cannot be operationalized in cases when model (1) leads to financial losses or when the Ramsey prices generated by model (2) are not sustainable against entry.

Attempts to implement the marginal cost pricing rule advanced by model (1) customarily reveal that there are powerful tensions between a policy based upon Short Run Marginal Cost (SRMC) and one based upon Long Run Marginal Cost (LRMC). First, the output to which the analysis refers must be defined: broad

[12] More recent literature has transferred the analysis of public enterprise and regulated industry prices into a principal-agent setting (Rees, 1984*b*).

[13] '[The inverse elasticity rule] says that the percentage deviation of price from marginal cost should be inversely proportional to elasticity. The intuitive rationale for this rule is that in achieving a required level of profit in a welfare optimal fashion those prices ought to be raised the most which will least distort the resulting output pattern from the socially efficient pattern obtainable through marginal-cost pricing. This suggests that contributions towards covering the deficit should be extracted more from products with inelastic demands than from those which are more price sensitive' (Crew and Kleindorfer, 1986, p. 18).

definitions may lead directly to cross subsidization.[14] Second, whereas SRMC pricing covers the relevant marginal operating costs, LRMC pricing covers the relevant marginal operating and marginal capital costs. If cross subsidy is to be measured with reference to benchmarks defined in terms of optimal pricing policy, this choice is clearly of vital importance. With an SRMC pricing benchmark, consumers who pay for marginal operating costs are not being cross subsidized. With an LRMC pricing benchmark, consumers are expected to contribute towards marginal capital costs, otherwise there may be the basis for a cross subsidy claim. The reason for the tension between the two is that they focus upon different objectives: SRMC pricing is designed to encourage efficient use of available capacity whereas LRMC pricing is designed to signal to consumers the marginal costs of capacity expansion. The use of SRMC pricing may stimulate growth in demand which it would be inefficient to meet in the longer term, whilst the use of LRMC pricing may leave existing capacity underutilized. An important consideration in utility sectors is that consumers themselves invest in durable goods for attachment to the network, meaning that it is vitally important that they understand price signals. For example, price reductions justified by SRMC pricing in cases of excess capacity might be wrongly interpreted as due to falls in LRMC: the crucial distinction is between a temporary and a permanent price reduction.

Unfortunately, LRMC is not unambiguous, either in terms of (i) what is being measured; or (ii) the values to be attached to the chosen formulation. Sanders *et al.* (1977) elaborated four possible definitions of LRMC in the context of water supply systems: 'textbook' marginal cost; 'textbook' long-run incremental cost; present worth of incremental system cost; and average incremental cost. Furthermore, it may be conceptualized either as the LRMC of expansion of the optimal plant mix or as the LRMC of expansion of an existing sub-optimal plant mix.[15] U.K. electricity pricing debates in the 1980s revolved around whether, in conditions of substantial excess capacity and economic recession, prices should be set on the basis of the LRMC of an optimized system, the LRMC of the existing sub-optimal system, or the SRMC of the existing sub-optimal system (Slater and Yarrow, 1983, 1985; Jones, 1985). Moreover, participants in the debate could readily anticipate how particular groups would be affected by particular rules.

A further set of considerations relates to the practical constraints on tariff design. Even in the complete absence of regulatory constraints upon differentiating price by geographical area or by other cost-relevant characteristics, there would be important matters of practicality to be addressed. Tariff design must take account of the capabilities and costs of metering technology and of the requirement that tariffs must be intelligible to consumers if they are to influence consumer behaviour and command public consent. Where competitive entry is prohibited, it is possible to

[14] 'Before marginal cost pricing can be applied in practice, we have to fix what is to be understood as a 'good' in the sense of our analysis. In practice we can start from a comparatively narrow conception (e.g. different categories of seats in theaters) or from a comparatively broad conception (regional unitary tariffs of railway, electricity, gas, and certain post services). The term 'broad conception' means unitary pricing for a good, in spite of different costs for various parts of production and in spite of differences in demand for this good. Unitary pricing thereby leads to internal subsidization. If . . . internal cross subsidization is unwanted, we have to split our good into different goods with varied pricing according to the marginal costs of the newly defined different goods. Usually, this will be cases of joint-cost production' (Bös, 1981, p. 39).

[15] The plant mix of electricity generation can be rendered severely sub-optimal by unforeseen developments, such as unexpected changes in technology and relative fuel prices.

calculate optimal pricing rules, chosen on efficiency grounds, which build in these complications. Even when efficiency is the sole concern, real-life tariffs must be a compromise between efficiency considerations and such practicalities: some cost-averaging internal to tariffs is inevitable. What is really at stake is not whether there is averaging, but the domain over which such averaging takes place. When competitive entry is permitted, such 'practicality-imposed' cost averaging may make the incumbent vulnerable to cream-skimming entry, whereby the entrant attacks only those market segments which are being averaged against.

Viewing cross subsidy from the perspective of optimal pricing clearly demonstrates the narrowness of a focus solely upon cost allocation. However, far from simple answers emerging there is a new set of complexities, leading to doubts about operationalization.[16]

6. Policy relevance in utility regulation

The definition and measurement of cross subsidy is of practical public policy relevance. Public utility sectors may exhibit one or more of eight cases (Heald, 1994). *Within a regulated sector,* there can be cross subsidy (1) between vertically integrated outputs (e.g. electricity generation and distribution); (2) arising from geographically uniform tariffs (e.g. uniform postal tariffs for mail within the European Union); and (3) between consumers of a single output when different categories of consumers are treated in 'economically unjustified' ways (injunctions to avoid 'undue discrimination' are uncertain in their impact without clear specifications of what constitutes 'discrimination' and 'undue'). *Between regulated sectors,* there can be (4) cross subsidy between horizontally integrated outputs (always a possibility when electricity and gas distribution are undertaken by the same company). *Between regulated and unregulated* sectors, four types of cross subsidy can be distinguished; (5) from a regulated sector to a 'related' input supplier (e.g. a water utility preferentially grants construction contracts to a company in the same group) (OFWAT, 1993*a*,*b*); (6) from a regulated sector to a competitive sector (e.g. an electric utility subsidizes its retail appliance operation); (7) out of a competitive into a regulated sector (e.g. civil engineering into utility distribution); and (8) mandated by government or regulator (as when OFTEL (1992) pressurized British Telecom to incur unremunerated expenditure on facilities for the deaf).

Cases (1) and (4) involve issues concerning the structure of the regulated sector. What is really at stake is the optimality of bundling, both in terms of production by the same firms and in terms of the packaging together of different outputs. Cases (2) and (3) raise fundamental issues about pricing policy. In practice, some of these cases may interact: for example, a given set of cross subsidies will have both customer-group and spatial dimensions. Cross subsidies to aluminium smelters or horticulturalists will have strongly concentrated spatial effects. Case (5) is really a particular example of the broader case (6), though it is analytically useful to keep them separate; both involve cross subsidies out of the regulated sector, though the

[16] Laffont and Tirole (1993, pp. 200–204) have extended the traditional Ramsey model to show that optimal pricing requires that each product's Lerner index [price-marginal cost ratio] be equal to the sum of a Ramsey index [defined to be independent of the firm's cost structure] and an incentive correction [to motivate managers to secure cost reductions]. Laffont and Tirole touched only briefly on why optimal pricing rules are so rarely followed in practice. They recognized that the benchmarks for cross subsidy measurement might be defined either in terms of marginal cost or of Ramsey prices.

former relies on input pricing and the latter on output pricing. Case (7) is probably relatively uncommon, most examples pertaining to the media. Finally, case (8) is rather different from the others, in that it could instead have been regarded as a particular version of each of the other seven cases: the crucial feature is that the cross subsidy is mandated by a public authority and not voluntarily chosen by the enterprise.

It has frequently been observed that publicly owned network-industry monopolies have traditionally had weak cost accounting systems (Vickers and Yarrow, 1988). In the U.K., where the political imperative was to denationalize quickly, this factor was repeatedly used as an argument against structural separation on product and/or geographical lines in advance of denationalization.

For the monopolistic publicly owned utility, there were weak incentives to develop elaborate cost accounting systems because:

(A) the monopoly position conferred exemption from the threat of competitive entry into a subset of output markets. Moreover, pricing policy was driven to a substantial extent by factors other than the pattern of accounting costs, due to either (i) a commitment to LRMC pricing which typically used linear and non-linear programming rather than detailed cost investigation using accounting data, or (ii) an explicit or implicit political imperative to set prices in ways which redistributed real income across geographical areas and/or consumer groups;

(B) those publicly owned network industries which were still government departments—or had only recently been corporatized—remained imbued with the traditional spirit of cash accounting and frequently did not have the necessary quantity or quality of accounting staff to develop and implement suitable cost allocation systems; and

(C) elaborate and expensive cost accounting systems were considered to be a poor use of scarce resources.

It is important to avoid the unquestioning assumption that the absence of developed cost accounting systems was *necessarily* a fault, though it *may* have been. For a judgement to be made, evidence would be required that such cost accounting systems would have been beneficial in the context of then prevailing objectives and conditions (e.g. a commitment to territorially uniform prices and the absence of exposure to competition). The present value of induced operational cost savings would have had to exceed the present value of the costs of installing and running 'complex' cost accounting systems.

Recent institutional and market changes have focused attention upon the development of cost accounting systems:

(1) market liberalization (such as the elimination of statutory barriers to entry and the promotion of common carrier arrangements);

(2) technological innovations (such as free-standing technologies like cellular and cable which introduce the possibilities of competition against certain parts of the network without duplicating entire systems);

(3) denationalization which produces clear incentives to maximize financial profitability by means which may include the abuse of monopoly power (Jones *et al.*, 1990); and

(4) the separation of the regulatory role—hitherto often performed at least

to some extent by the public enterprise itself—from the operational role, thereby inducing a more formalized regulatory style. Sectoral regulatory agencies may attempt to impose cost allocation systems upon operators in order to produce regulation-relevant data.

There is a striking paradox concerning cost allocation systems in network industries which is profoundly important for public policy towards cross subsidy. The traditional publicly owned network monopolies had limited incentives to develop elaborate cost accounting and cost allocation systems. Quite apart from statutory protection from competition, they often believed that their social mission made cross subsidy an acceptable business practice.[17] In consequence, they were often prepared to explain their internal procedures to interested outsiders. Whilst their successors (especially if privatized and thus focused more decisively upon profit as the overriding business objective) have much greater incentive to develop cost accounting and cost allocation systems, there are compelling reasons for concealing as much as possible from the public gaze, treating both procedures and data as 'commercial in confidence'. There is a serious danger that the best studies—defined as those combining technical sophistication with access to primary data and then reported fully—will disappear from the public domain.[18] Indeed, where companies are quoted on stock exchanges, this information might be market sensitive. Unless the sectoral regulatory body, which may itself have been the driving force for the development of the systems generating these data, is willing to publish both methodology and results, outside researchers will be sorely handicapped.[19] Whilst market liberalization and denationalization will lead to the elimination of socially motivated cross subsidy, more aggressively profit-seeking enterprises will view the predatory use of cross subsidy as a tool of commercial policy.

[17] 'Cross subsidization—supplying one group of consumers at a loss which is made up by profits on sales to other consumers—is very prevalent in public enterprises, and this can be viewed as a particular way of allocating the rents associated with the activity' (Rees, 1984*a*, p. 5). 'Many of the social obligations found in nationalization statutes, and other policies like those of cross-subsidization which have persisted past privatization in some cases, originated in the personal and political preferences of Victorian statesmen' (Foster, 1992, p. 33).

[18] The revenue trade-offs methodology developed as a proxy approach to cross subsidy measurement has been applied in a series of pioneering studies within France Telecom (de la Brunetière and Curien, 1984; Curien, 1985, 1991; Curien and Gensollen, 1992): '. . . marginal costs being taken as a reference, transfers of revenues originate in discrepancies between the rates of return made on different types of subscribers or on different categories of service' (Curien, 1991, p. 101); '[Costs] have been calculated so that their structure is that of marginal costs and their level such that total costs equate total revenues' (p. 101); '[The revenue trade-offs approach to cross-subsidies] fully distributes the global expenses of the firm towards all possible subsets $\mathcal{J}$ of outputs *by resorting to conventional rules* for the allocation of joint and fixed costs' (p. 82, italics added). The benchmark for the measurement of revenue trade-offs is the vector of marginal costs, reflecting the pursuit of first-best welfare maximization. However, the results generated by these studies depend upon the 'usual practice of reallocating profits in proportion to costs or to revenues when computing cross-subsidies' (p. 85), a practice which can readily be challenged. The updating to 1984 data (Curien, 1991) of the earlier study on 1981 data (de la Brunetière and Curien, 1984) led to conclusions on desirable tariff rebalancing which would, if implemented, have reduced average business bills by 28% and increased the average residential bill by 25%, whilst raising rural subscribers' bills by 71% and reducing those of subscribers in medium and large cities by, respectively, 6% and 19%. Although France Telecom continues to update these estimates, they are no longer published. The withdrawal of such information from the public domain is attributable to the much greater commercial and political sensitivity of such matters in the 1990s, and to ministerial refusals to allow the scale of tariff rebalancing which France Telecom has desired.

[19] The published data showing remarkably different rates of profitability for BT's lines of business (OFTEL, 1992, paras 15–21) are impossible to interpret without fuller explanation than: 'The data relate to BT's fully allocated cost accounts prepared under the historic cost accounting convention' (para. 16).

7. Conclusion

The definition and measurement of cross subsidy is one of management accounting's most pronounced interfaces with public policy. Analytical clarity is essential, particularly because this is a context in which language is often used both imprecisely and persuasively. The insights derived from the utility examples have a relevance to competition policy in other sectors of the economy (market entry subsidized from other activities and predatory pricing) and to the design of management accounting systems within firms (where there are often competing claims about the existence of cross subsidy). Accountants have a major contribution to make in the operationalization of cross subsidy measurement, arising from both their analytical understanding of cost behaviour and their expertise in the design of cost measurement systems. A proper appreciation of how cross subsidy definition and measurement derives from the theory of industrial structure will both equip them for such a task and protect them from being used simply as technicians to compile cost data without theoretical underpinnings—a guaranteed route to being criticized by economists and to being marginalized from public policy-making.

Cross subsidy has been shown to raise difficult issues of identification, measurement and public policy response. First, there is a dispute about whether cross subsidy measurement is in fact related to cost allocation. Bös has sharply downgraded the significance of cross subsidy measures derived from cost data:

> Let us conclude by pointing out that the problem of cross-subsidization is of no importance from the point of view of welfare economics. If optimal pricing includes any kind of cross-subsidization (of the Faulhaber type or of an extended type), then that cross-subsidization should be accepted (Bös, 1986, p. 194).

Just before reaching this conclusion, he had commented that:

> . . . in a profitable enterprise some goods may be subsidized although the prices are cost covering and they could 'go it alone'. In the long run this problem will, of course, only exist if entry to this market is forbidden (pp. 193–194).

Nevertheless, virtually all published empirical studies start from cost allocation.

Second, the process of cost allocation is in part technical and in part political. The tempting search for unique technical solutions will generate only frustration; 'answers' may be extremely sensitive to the procedures and parameters chosen. In cases where there are no incontrovertible technical answers, participants in the policy process (dominant incumbents, potential entrants, consumers, regulators and governments) may have strong economic incentives to support particular technical solutions to the cost allocation problem, for reasons which are demonstrably congruent to their economic interests. Truthful revelation of relevant data cannot be assumed: those who generate such cost allocations are likely to understand the data and the sensitivities far better than any outsider. When a particular set of cost allocation rules is chosen, those doing the choosing are not unaware of how their choice affects particular outputs and thus groups of consumers. As a corollary, if one knows the intended result, it is usually not difficult to develop a plausible argument in favour of a rule which is known to deliver that result. Moreover, costs—particularly the costs of capital services—are not measured unambiguously. The measurement of accounting costs is strongly affected by accounting rules and conventions about the valuation of assets and the measurement of depreciation, a

particularly difficult and important area in capital-intensive sectors which have long-lived assets and which are experiencing rapid technological progress. In the context of public utilities, these issues can substantially affect calculations of profitability and conclusions about whether capital maintenance has been achieved (Tweedie and Whittington, 1985; Whittington, 1985; Byatt, 1986).

Third, there are marked swings in the academic mood about cost allocation studies. Thus, Cave *et al.* (1990, p. 520) pronounced themselves confident about the usefulness of cost allocation exercises, associating themselves with 'Kahn's (1970) belief in the ''objective reality'' of cost causation (even though it may have to be done by ''rough rule of thumb approximation'') rather than his 1987 [Kahn and Shew, 1987] strictures on the ''ritualistic, incantational role of cost allocation'''. The difference in view between Cave *et al.* (1990) and Kahn and Shew (1987) is probably due in part to differences in institutional context: whilst cost allocation exercises have a long history in the U.S., their contemporary importance in the U.K. stems from the formalized regulation which accompanied denationalization. Cave *et al.* (1990) reported an innovatory cost allocation study of Kingston Communications (Hull) plc, a small municipally owned telecommunications firm whose existence has been a historical anomaly. Significantly, this study was jointly sponsored by OFTEL and the company itself. The study primarily used FDC methodology, though it also discussed the applicability of SAC. It stressed the importance of conceiving of activities in hierarchies: costs may be joint or common at one particular level in the activity hierarchy but can unequivocally be allocated to particular branches at higher levels. Cost allocation for regulatory purposes has to be wary of the danger of circularity: for instance, performing cost allocations on the basis of revenue shares when tariffs are themselves regulated on the basis of costs. Benchmark definition for cross subsidy measurement is inevitably imperfect; the practical issue is always whether what can be done is worth doing and is defensible. The kernel of Curien's (1991, p. 82) argument is that because theoretically sophisticated benchmarks such as Ramsey, Shapley and Aumann-Shapley prices require 'almost full identification of the cost function or . . . data on the demand functions . . . [this] explains why theoretically based allocations are very generally ignored by current accounting practice'.[20] In the absence of regulatory prohibitions, denationalization will lead to the emergence of enterprises which span more than one regulated sector and which operate in both regulated and unregulated sectors,[21] whilst subject to regulatory requirements for accounting separation (Cave and Martin, 1994). Analytical clarity about cross subsidy is a necessary foundation of effective utility regulation.

Fourth, common costs are a nuisance in accounting terms because they render ambiguous the cost of particular outputs. In economic terms, they represent a source both of substantial productivity gains (achieved through the exploitation of economies of scope) and of potentially intractable competition policy problems.[22] Therefore, substantial uncertainty attaches to the desirable public policy response:

[20] This explains the importance which Palmer (1991, 1992) attached to developing an empirical methodology which can resort to IC measures as a substitute for direct SAC measurement.
[21] For example, energy conglomerates will emerge, and structural separations imposed at the time of denationalization will be undone via the capital market.
[22] 'Common and joint costs are a headache to regulators, but a boon to consumers' (Cave and Mills, 1992, p. 14).

the imposition of accounting straitjackets may prevent the realization of potential productivity gains whilst an absence of public policy response may permit firms whose primary activities are in monopolized markets to dominate adjacent markets through (what are perceived to be) anti-competitive practices. What makes the issue of cost allocation both more important and more difficult is the reputed increase in the proportion of costs which are common to multiple outputs. Telecommunications is a good example of this, with sunk fixed costs higher and variable costs lower. A crucial policy issue in regulated sectors is whether the regulator imposes a highly structured and detailed cost allocation system upon the sector as a means of generating comparable data. There is a paradox here. Without comparable cost data, the cross subsidy problem cannot be satisfactorily addressed. Yet, with comparable cost data, these policy interventions may indirectly undermine market incentives for cost reduction; costs may be higher than those which would have existed in the absence of the prescribed cost allocation system. There is thus a potential trade-off between devising mechanisms by which costs can be reduced and those by which any given level of costs can be allocated across outputs.

Fifth, when allocating costs between products and thus to groups of consumers, it is vital to be clear about what exactly is being allocated to what. Typically, allocation is of *accounting costs* to existing products and thereby to groups of consumers. It is possible to think of two alternative bases which, even if less operational, are more intellectually coherent. Instead of accounting costs, the allocation process could focus upon *cash flows*. Where businesses are changing, and the mix of products and consumer groups are themselves changing, the allocation process ought to focus upon the *discounted cash flows* associated with particular products and groups of consumers, present and future. Otherwise, because of life-cycle effects (reflected in peaks and troughs of investment expenditure associated with particular products and consumer groups), cost allocation exercises which focus upon accounting costs may give seriously distorted answers. When attempting to make judgements about cross subsidy, it is necessary to assess whether the business as a whole would be better off without particular segments (Brown and Sibley, 1986, p. 49). This question can only be satisfactorily answered by means of DCF appraisals which look beyond annual accounting data and which explicitly acknowledge the time dimension of cash flows. Curien (1991) emphasized the limitations of annual snapshots as reliable indicators of the existence and extent of cross subsidy. There is a regulatory demand for the kinds of information which Wilson (1991) has characterized as being required for strategic management accounting by the business.

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