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競爭環境下公營事業共同成本分攤的檢驗機制

張玉山
國立中山大學副教授

摘要

多產品廠商的共同成本分攤雖爲一老生常談的問題，但對台灣公營事業仍非常重要。面對著自由化及解除管制的趨勢，公營事業如何有效率的定價及分攤成本日趨重要。本文藉著合作賽局論的應用，以發展公營事業聯產品共同成本分攤的效率測試，並將測試範圍延伸至考慮國際競爭因素的情形。最後，本文討論當現行公營事業在競爭環境下無法繼續營運時，所需作的調整。同時，我們將進一步的討論，公營事業爲達其他政策目標時，市場所需的保護。

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Cost Allocation Tests for the Public Enterprises in a Competitive Environment

Yue-shan Chang*
National Sun Yat-sen University

Abstract

The common cost allocation of a multi-product firm is an old accounting problem. It, however, has significance for the public enterprises here in Taiwan. Facing the trend of deregulation and liberalization, it is vital for the public enterprise to price its product and allocate its cost efficiently. By applying results from cooperative game theory, this paper introduces efficiency tests for common cost allocation in a multi-product public enterprise. The tests are extended to consider cases where international competition is possible. Finally, this paper discusses the necessary adjustments needed when the current operation of the public enterprise can not be sustained in a competitive environment. Furthermore, the minimum protection needed by the public enterprise in order to achieve other policy objectives is also discussed.

1. Introduction

The common cost allocation is an old but important problem for a public enterprise with multi-products (joint products). Since, the contribution

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of common resources to each product is hard to identify, the ways to assign common cost to each product are also unclear. Furthermore, as the pricing of public enterprise's products usually depends upon their assigned cost, the method to allocate cost of joint products also determines the prices of these products [1].The joint cost allocation problem carries special significance for the public enterprises in Taiwan. Facing the trend of deregulation and liberalization, public enterprises here find the threat of competition increasingly credible. Under a competitive environment, efficient operation of the public enterprise and, more specifically, efficient cost allocation and pricing of the multi-products (joint products) becomes an important issue.

When the public enterprise is protected from competition, the common cost allocation is a trivial problem. The common cost can be allocated among its joint products (and priced accordingly) in a number of arbitrary ways [2].As a result, cross subsidization between the products may occur. Some products may be sold below (above) its due cost. This phenomenon (cross subsidization) does not create problems for the public enterprise in a protected environment. As long as the over-all revenue covers the over-all production cost, the public enterprise can operate without any difficulty.

Once, however, the market protection is lifted, as soon will be the case here, arbitrary joint cost allocation scheme may not stand against the competitors' challenge. The competitors can avoid the subsidized (low price) product markets and compete with the public enterprise in the unsubsidized (high price) markets. Since the competitors need not bear the burden of subsidization in the low price markets, they enjoy competitive advantage in the remaining high price markets. Therefore, in a competitive environment, cost should be allocated in such a manner that cross subsidization between products should not occur. In other words, the competitive cost allocation mechanism should be "subsidy-free". The "subsidy-free" requirement is an abstract concept. To be operational, specific tests are needed. As the "subsidy-free" requirement is necessary for any competitive cost allo-

[1]The pricing principle for the products of a public enterprise here is to "reflect its due cost".For instance, according to the Energy Policy now adopted by the Administrative Yuan,the prices of all petrochemical products should be set to "reflect their due costs". Products of other public enterprises are subject to similar pricing rules.

[2]For instance, the Chinese Petroleum Corp. currently allocates its joint cost according to the prices of its products, and the Directorate General of Telecommuncations allocates its joint cost by some specific physical measures.

cation mechanism, the "subsidy-free" test therefore constitutes a test for competability.

The purposes of this paper are two folds. (1) To develop workable cross-subsidization tests for the joint cost allocation schemes under various market environments. (2) Based on the results developed in (1), this paper proceeds to study the necessary market limitations needed for different policy objectives. Recent development in the cooperative game theory has provided us a ready tool for our purposes. In this paper we apply some well-known results in the cooperative game theory in developing tests for the common (joint) cost allocation scheme. The necessity of some limitations on market competition for various policy purposes is also discussed. In deriving its analytical tool, this paper follows a similar approach adopted by Sharkey [8], and applies the result to the state-owned enterprises in Taiwan. The paper is organized as follows: In Section 2, we develop tests for "subsidy-free" cost allocations. In Section 3, we extend our criteria to incorporate considerations of international competition. In Section 4, we discuss the adjustment of public enterprise's products combination, when no competitive "subsidy-free" prices can be achieved. Also we discuss the necessary market limitations needed when, for some policy reasons, we want to maintain some products subsidized. Our conclusions are in Section 5.

2. Common Cost Allocation and Subsidy-Free Prices

In this section, we elaborate the concept of "subsidy-free" prices, and analyze their properties. In order to illustrate, we start with a simple example. A public enterprise produce two products, x and y by using a common input. The total cost of producing x and y can be expressed by: $C(x,y) = C_0 + C_x + C_y$, where C_x and C_y are the costs that can be directly attributed to product x and y, and C_0 is the common cost of producing x and y. Let P_x and P_y be the prices of x and y in the product markets. If (1) the cost of production can be fully recovered ($P_x + P_y = C(x,y)$) and (2) the price of each product exceeds its individual cost ($P_x > C_x$ and $P_y > C_y$), then we call the set of prices (P_x, P_y) "subsidy- free".

This notion of "subsidy-free" prices can further be extended to public enterprise with many products in a similar fashion. Let N={1,..., n} denotes the set of all possible products of a public enterprise. Similarly, the set of "subsidy-free" prices, $\{P_1, P_2, ..., P_n\}$, should satisfy the following two conditions:

$$\sum_{i=1}^{n} P_i = C(N) \tag{1}$$

$$\sum_{i \in s} P_i \geq C(N) - C(N/S), \text{ for all } S \subseteq N \tag{2}$$

Condition (1) says nothing but that the production cost should be fully reflected in the product prices, and condition (2) means that the prices of any subset of products should at least cover the incremental cost of producing these products. Condition (2) can, in turn, be interpreted as an "incremental cost test" for cross subsidization between products. Subtracting (2) from (1), we can further derive condition (3).

$$\sum_{i \in s} P_i \leq C(S) \tag{3}$$

Condition (3) suggests that to prevent cross subsidization, the prices of any subset of products should be lower than the cost of producing these product independently. If this condition is violated, then new firm can form by simply producing the subset of product S. Condition (3) can, therefore, be interpreted as a "stand alone test" for "subsidy-free" prices.

For a public enterprise facing competition in some of its product markets, the "subsidy-free" prices are necessary condition for economic efficiency. In other words, conditions (1) and (2) (or (3)) must hold in order to ensure the basic requirement of economic efficiency. We illustrate this point with an example.

As an example, we assume the cost function of the public enterprise is subadditive. That is, we assume the cost function satisfy the following relation: $C(S) + C(T) > C(S \cup T)$, for $S \cap T \neq \emptyset$. The assumption of subadditive cost function simply implies that the firm has economy of scope in its production activities, which is a natural assumption for most state-owned enterprises. Now, suppose condition (3) is violated, and there exists some subset of products, S, $S \subset N$, such that $\sum_{i \in s} P_i > C(S)$. This, in turn, implies the subset of products, S, is subsidizing the remaining subset of products, N/S. This point can be further elaborated by subtracting $\sum_{i \in s} P_i \leq C(S)$ from condition (1). Conditions (4) and (5) can then be derived.

$$\sum_{i \in n/s} P_i < C(N) - C(S) < C(N/S) \tag{4}$$

$$\sum_{i \in s} P_i > C(S) > C(N) - C(N/S) \tag{5}$$

Suppose there is a competitor, who can produce the subset S at a cost $H(S)$, such that: $\sum_{i \in s} P_i > H(S) > C(S) > C(N) - C(N/S)$. Under the circumstance, the competitor can supply the subset of products S with lower prices, $H(S)$, and takes over the entire market of S. As a result of competition, the prices of subsidized products, N/S, will go up (This can be seen from condition (4).). The cost of providing N/S becomes its stand alone cost, $C(N/S)$. As a result of competition, the society's total cost of production will be higher than before.

$$H(S) + C(N/S) > C(N) - C(N/S) + C(N/S) = C(N) \tag{6}$$

Equation (6) illustrates that when condition (3) is violated, cross subsidization between products will occur. The phenomenon (cross subsidization) implies profitable opportunities for the competitors, and entry may take place in the unsubsidized markets. As a result of the competition, the subsidized consumers as well as the society's production efficiency as a whole will suffer. To conclude this section, condition (3) (stand alone test) and/or condition (2) (incremental cost test) are tests for "subsidy-free" prices, and a set of "subsidy-free" prices is the necessary condition for economic efficiency.

3. International Competition and Subsidy-Free Prices

Passing the "incremental cost test" or the "stand alone test" guarantees a set of "subsidy-free" prices. A set of "subsidy-free" prices is, however, only the necessary condition for economic efficiency. It is not sufficient to determine the enterprise's cost allocation and pricing decisions. Several points worth stressing: (1) There may exist many sets of "subsidy-free" prices. That is, the "stand alone test" or the "incremental cost test" can not determine a unique set of product prices. (2) These tests are based only on the public enterprise's own cost function, they do not consider the competition from outside environment. For instance, suppose besides domestic production, products can also be imported from abroad. If it is the case, product prices in the international market should also be considered as constraining factors in the common cost allocation.

We shall further elaborate the second point with an example. Suppose, in the example discussed in Section 2, the product prices are adjusted so that no cross subsidization occurs. Hence, the set of prices, $\{P_1, P_2, ..., P_n\}$, is "subsidy-free". Suppose further that the competitor can import some subsets of products, S, $S \subset N$, at costs $G(S)$, $S \subset N$. If $G(S) < C(S)$ and $C(N) - C(N/S) < G(S) < \sum_{i \in s} P_i \leq C(S)$, then the competitor can still take over the markets of subset S even if $\{P_i\}$ is "subsidy-free". If this happens, the consumers of the remaining subset of products, N/S, will have to pay a higher cost, $C(N/S)$, and the production efficiency of the whole society will also suffer. (Since, $C(N/S) + G(S) > C(N)$.) Therefore, if there are alternative sources of products (import), "subsidy-free" prices alone no longer guarantee efficiency. We must also consider the limitation imposed by the environment when allocating the product costs.

To extend our analysis to include the consideration of foreign competition, we proceed as follows: Let the international prices of the products be denoted by $\{A_1, A_2, ..., A_n\}$. To be competitive, the cost allocation and pricing of the public enterprise's products must satisfy three conditions.

$$\sum_{i=1}^{N} P_i = C(N) \tag{7}$$

$$\sum_{i \in s} P_i \geq C(N) - C(N/S), \text{ for all } S \subseteq N \tag{8}$$

$$P_i \leq A_i, \text{for all } i \in N \tag{9}$$

Conditions (7) and (8) merely restate conditions (1) and (2). Condition (9) represents the additional limitations imposed by the potential foreign competitors. It is clear that conditions (7), (8) and (9) are tougher criteria to satisfy. One might wonder whether any cost allocation rule can simultaneously satisfy all three conditions. Indeed, when considering international competition, competitive "subsidy- free" prices may not at all exist. Technical requirements on the shape of cost function that guarantee solutions have been developed (see, for instance, Sharkey [7]). In this paper, however, we save ourselves from the technical aspects, and focus on the adjustment strategies of the public enterprises and the policy considerations of the government when the "subsidy-free" prices fail to exist.

4. Adjustment Strategies and Policy Considerations When Subsidy-Free Prices Do Not Exist

If a public enterprise can not allocate cost to satisfy conditions (7), (8) and (9) simultaneously, then it can not maintain current level of operations when facing competition. Then either (1) adjustment must be made to the current bundle of products by the public enterprise or (2) some limitations on the product markets are needed in order to sustain the public enterprise. This section discusses the necessary adjustment of the product mix of the public enterprises and the necessary limitations on the competition in order to sustain it.

Since, in a competitive environment, conditions (7), (8) and (9) must hold for any multi-product firm, this should also hold for the multi-product public enterprise. If a public enterprise with the product set,N, can not allocate its common cost to satisfy all three conditions, then adjustment must be made to the size of its product set in order to survive in the competitive market. A competitive product set can be developed by the following steps: (1) For any subset, S, $S \subset N$, check whether S satisfy conditions (7), (8) and (9). (2) Denote the set of all the subsets that satisfy conditions (7), (8) and (9) by S, $S=\{S_1, S_2, ..., S_I\}$. The optimal product bundle (the subset S_i) can be determined by the subset that maximizes the objectives of the government – consumer and producer surplus. (3) if, however, no subset of products can satisfy the three conditions simultaneously, i.e. $S = \emptyset$, then fundamental improvement must be made to the firm's production (cost) function. Or else the firm may not survive in a perfectly competitive market environment.

There are times that perfect competition does not serve the public interests. For various policy reasons [3], the government may like to keep some of the products that otherwise can not survive in a competitive environment. Some protection is needed. Too much protection, however, breeds inefficiency. To ensure economic efficiency as well as policy objective, only minimum protection should be devised. How, then, can the minimum protection be identified?

This paper introduces a method to determine the minimum protection needed to sustain a given public enterprise with some cross subsidization

[3]Say, for instance, economic equity.

between products. From the analysis above, we know that the cross subsidization of products can not exist in a perfectly competitive environment. That is, the system of equations (7), (8) and (9) can not be satisfied simultaneously by a set of cross subsidized prices, $\{\tilde{P}_1, \tilde{P}_2, ..., \tilde{P}_n\}$. One way of achieving policy objective (some degree of product subsidization) as well as economic efficiency is by redefining the public enterprise's "product". By grouping the cross subsidized products as a new "product", the public enterprise can alleviate the undesirable competition caused by products cross subsidization. The "product bundling", therefore, can be seen as a protective measure. The finest partition of product bundles that can sustain the public enterprise in the competitive market is the minimum protection needed. Once the policy decision has been made, government can devise protective measure to achieve its goal by redefining "products" by various product bundles.

5. Conclusion

The common cost allocation of a multi-product firm is an old accounting problem. It, however, has significance for the public enterprises here in Taiwan. Facing the trend of deregulation and liberalization, it is vital for the public enterprise to price its product and allocate its cost efficiently. By applying results from cooperative game theory, this paper introduces efficiency tests for common cost allocation in a multi-product public enterprise. The tests are extended to consider cases where international competition is possible. Finally, this paper discusses the necessary adjustments needed when the current operation of the public enterprise can not be sustained in a competitive environment. Furthermore, the minimum protection needed by the public enterprise in order to achieve other policy objectives is also discussed.

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