MONASH UNIVERSITY

DEPARTMENT OF ECONOMICS

EC579 : BENEFIT-COST ANALYSIS

Professor R.M. Parish

THREE CONCEPTIONS OF SHADOW PRICES

Much confusion has arisen in the literature dealing with project appraisal from the fact that the term "shadow price", or "accounting price", means different things to different authors - or even to the same author at different times. Common to all usages is the notion that the shadow price should measure the social value or opportunity cost of a good or service produced by, or used in, an investment project; and that the use of a shadow price is called for when the market price does not properly measure social value or cost. Differences exist, however, concerning the context in which social values and costs should be measured - "context", in this connection, meaning the trade and production transformations that are deemed to be open to the society.

A situation calling for the use of a shadow price is one in which advantage is not being taken of some favourable transformation possibility. As a result, there is a discrepancy between the marginal social value (MSV) and the marginal social cost (MSC) of some good or service. The source of the discrepancy may be the existence of a tax, a tariff, or a subsidy, a monopoly or a monopsony, an externality, or direct controls of price or quantity. There appear to be at least three, and possibly more, conceptions of what constitutes such a good's shadow price.[1]

---

1. I am considering here only conceptual differences. In addition, in an attempt to meet the requirements of "practical men", various rules of thumb for determining shadow prices have been proposed. Prices so determined are usually approximations to one or other of the concepts to be discussed below, but it is not always apparent which concept it is intended to approximate.

...2/

"Ceteris Paribus", "Marginal Social Value", and "Utopian" Shadow Prices

First, there is what might be termed the "ceteris paribus" shadow price. This price (which I shall refer to as P_1) should be such that, when applied to the quantity of the good involved in the project as an input or output, it accurately measures the resulting change in the social welfare indicator. In order for it to do so, it must reflect the actual response that society is expected to make to the increased supply of, or demand for, the good; and this involves recognizing that the policy or institutional constraint that is causing the current discrepancy between MSV and MSC will continue to operate.[2] In other words, the only change that is considered is the implementation of the project itself: hence the coinage, "ceteris paribus" shadow price.

Second, the good's current MSV might be chosen as its shadow price, on the grounds that this value also constitutes its true opportunity cost. However, the MSV shadow price (or P_2) will reflect the good's opportunity cost only if it is assumed that the presently unexploited transformation option can be exercised, on the margin, in an advantageous way. This would require, of course, a marginal relaxation of the existing constraint.

Third, the good might be valued on the basis of the price at which MSV and MSC would be equalized if the existing constraint were to be removed. I propose to call this the "Utopian" shadow price, or P_3.

An Illustrative Example

The easiest way of comparing these three concepts is by means of an example. Suppose that the social welfare indicator to be used in

---

2. Unless, of course, it is expected that the constraint will be relaxed before or during the life of the project.

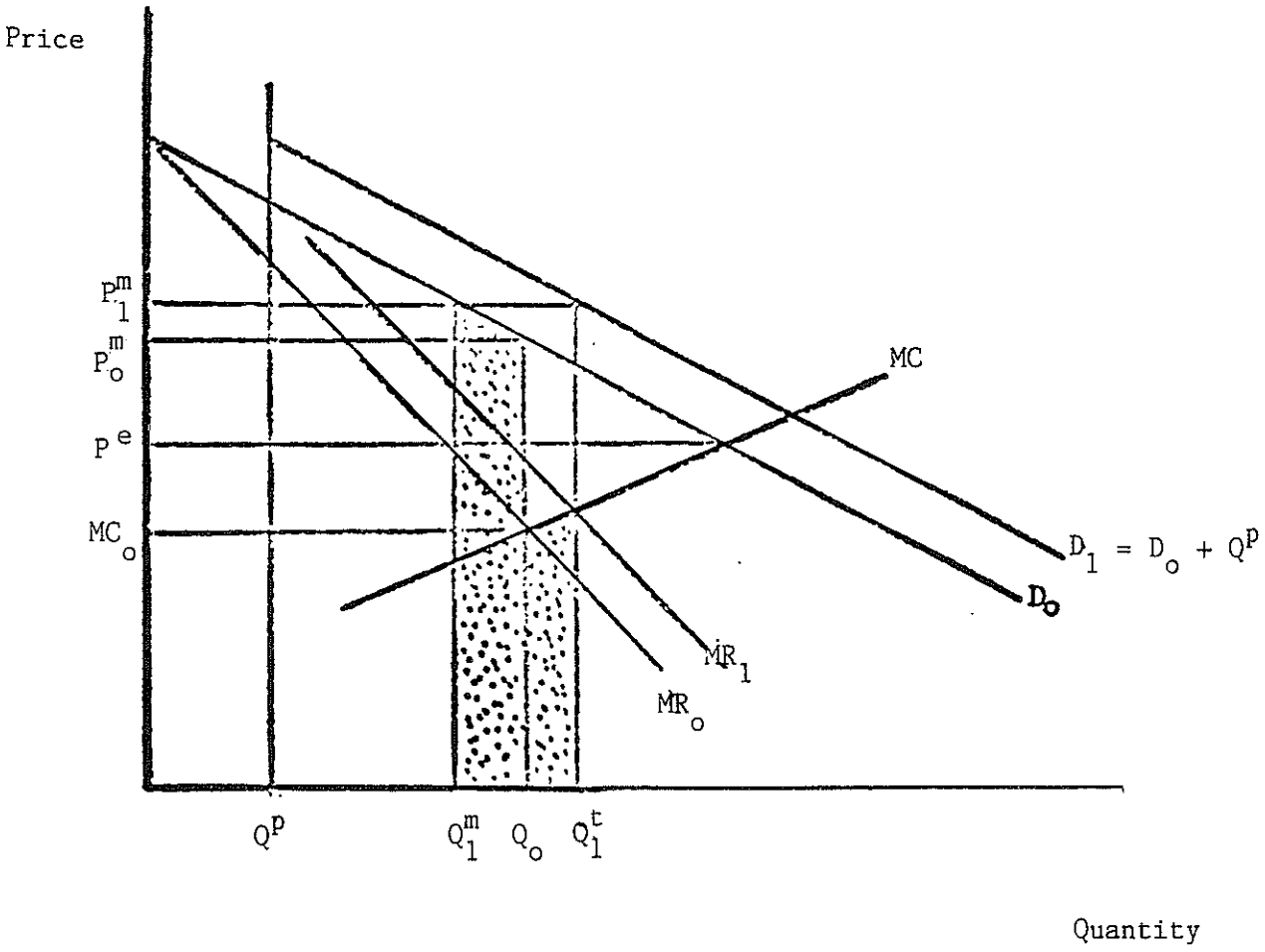
...3/

appraising an investment project is the money value of aggregate consumption, and consider the question of what accounting price to attach to a material input of the project that, being produced by a monopolist, has a market price exceeding its marginal cost of production. (We confine our attention to just one commodity which is used as a material input to the investment project.)

In order to derive P_1, one has to analyze the efffects on production and consumption of the increase in the demand for the material which will eventuate if the project is implemented. This is done in Figure 1, where the quantity required by the project is treated as an autonomous and inelastic addition to the total demand. The increased demand leads to a rise in price and marginal revenue which results in both increased production by the monopolist and decreased consumption by existing consumers. The value of the consumption given up, if measured by consumers' willingness to pay, is the area under the demand curve, over the interval $Q_1^m Q_o$. The cost of additional production, $Q_o Q_1^t$, is the value of the output of other things lost through the diversion of resources to the production of the material. If input prices reflect social opportunity costs, the value of this output foregone is measured by the area under the marginal cost curve over the interval $Q_o Q_1^t$. Hence the total cost to society of using Q^p of the material in the project is measured by the shaded area, and the shadow price of the material is this area divided by Q^p. Disregarding the marginal changes in market price and marginal cost induced by the project, the shadow price of the material is a weighted average of a market price P_o^m) and marginal cost (MC_o), the respective weights being the proportion of the quantity required that comes from reduced

...4/

Figure 1



The subscript zero refers to the without-project situation; the subscript one to the with-project situation

Q^p is the quantity required by the project: it is treated as an inelastic addition to total demand

Q_1^m is the quantity demanded by non-project users of the material if the project is implemented

$Q_1^t - Q_1^m = Q^p$

consumption of the material by others, and the proportion that comes from increased production by the monopolist.[3]

The P_2 shadow price of the material is given by its demand price, i.e., it is approximated by P_o^m. The material is valued at its market price irrespective of whether the project demand is accommodated at the expense of existing consumers, or through increased production. For, the argument runs, the real opportunity cost of using the increased production in the project is the price that consumers would be willing to pay for that increased production. Because it is possible to transform resources worth MC_o into a unit of material worth P_o^m, they should be valued at the higher price. The fact that, given the existence of the monopoly, this technical transformation opportunity will remain unexploited - unless total demand for the material expands - is ignored.

The Utopian shadow price, P_3, is the price that would prevail if production of the material were to be allowed to expand to the point where market price equalled marginal cost. This is the price P^e in Figure 1. For such an expansion of production to actually occur would, of course, require the breaking or regulation of the monopoly or the payment of an appropriate production subsidy.

---

3. In some cases the weights will be one and zero, or zero and one, i.e., the entire quantity will be valued at its MSV or at its MSC. For example, if the marginal cost of increasing output of the material was very high - the monopolist was working at "full-capacity" - the project's requirements would be met solely at the expense of existing consumers, and hence should be valued at the market price. In competitive situations, where the source of the discrepancy between MSV and MSC in a tax, tariff, or subsidy, the good should be valued at its demand price if supply is absolutely inelastic or demand is perfectly elastic, and its supply price if supply is perfectly elastic or demand is quite inelastic.

   For a more detailed discussion, see R.M. Parish, On How to Interpret Ambiguous Market Signals When Appraising Investment Projects. IBRD, mimeo, Jan., 1972.

...6/

Comparison of the Three Shadow Prices

Of the three prices, only P_1 provides a conceptually accurate measure of the social costs and benefits of a project, given the existing state of the economy. In the example illustrated in Figure 1, P_2 would overstate the social costs of using the material input: this is because it charges the project with depriving consumers of a quantity of the material $Q_oQ_1^t$, that they did not possess in the first place.[4] On the other hand, P_3 would, in the example given, understate the cost of the material, since the competitive equilibrium price would be less than P_1. Thus use of P_2 could lead to the rejection of a project that would, if implemented, be socially desirable; and use of P_3 could cause a project to be accepted that would be socially disadvantageous in the existing circumstances.

In the particular example being considered, P_2 exceeds both P_1 and P_3. This is an example of the more general proposition that when the three prices are not identical, P_2 will be the highest or the lowest of the three: when MSV $\neq$ MSC, P_1 (a weighted average of the two) and P_3 (the equilibrium price) will both lie between MSV and MSC, whereas P_2 will correspond with the MSV. In a number of cases (though not in that of monopoly being considered here) P_1 will equal P_3, and in many more P_1 and P_3 will be approximately equal. For example, if the discrepancy between MSV and MSC were the result of an excise tax or subsidy, and the supply and demand curves were linear, the weighted average price P_1 can be shown to be equal to the equilibrium price P_3.

---

4. For P_2 to be a correct measure, it would have to be supposed that, in the absence of the project, the monopolist could be forced to expand his output from Q_o to Q_1^t - i.e., that it is possible to relax marginally the constraint which causes MSV and MSC to differ - and that his output would remain unchanged after the project was implemented.

...7/

Suppose our material-using project would be socially profitable if the material were valued at P_1 or P_3, but unprofitable if it were valued at P_2. If would make sense to reject the project only if the option of expanding production of the material for sale on the open market could be, and was, exercised. Let us suppose that at least an incremental expansion in material production was secured by means of anti-trust action, monopoly regulation, payment of a subsidy, or similar device. If the original project were now re-examined, it would be found that P_2 had fallen somewhat, P_1 had fallen also, but by a lesser amount, and P_3 had remained unchanged. The project would still be profitable if the material was valued at P_3, would be more profitable if it was valued at P_1, and may now be profitable in terms of P_2. If this is so, no problem arises; the project should be implemented. But if it is still unprofitable if P_2 is used, we go through the same process again, i.e., determine whether or not it is feasible to expand output of the material still further. Sooner or later the project is accepted, either because the option of expanding output of the material by curbing or offsetting the monopoly power of the producer is no longer open, in which case P_2 becomes irrelevant and the project is accepted on the basis of P_1 or P_3; or because P_2 falls to the point where the project is acceptable when the material is valued at P_2. (Of course, this might be where $P_1 = P_2 = P_3$, i.e., full competitive equilibrium.) The moral is, if a project is profitable if valued at P_1 and P_3, and if adjustment towards equilibrium takes place along monotonically-increasing or decreasing functions, accept the project, irrespective of its profitability if valued at P_2. In such a case, P_2 is dominated by P_1 and P_3 as a guide to resource allocation, and hence can be disregarded.

...8/

To consider a different case, suppose that initially $P_2 > P_3 > P_1$, (or $P_2 < P_3 < P_1$), and the project is acceptable only on the basis of P_1. If the constraint that causes P_2 to differ from P_1 cannot be relaxed, P_2 is irrevelant, and the project should be accepted on the basis of P_1. If the constraint can and will be relaxed, the project should be evaluated on the basis of the P_1 that will prevail after the relaxation. The second P_1 will, given the monotony assumption, be higher (lower) than the first, since with relaxation of the constraint, P_1 will move toward P_3. The project, therefore, may or may not be acceptable at the new P_1. But again, P_2 is not a useful guide in project evaluation.

A similar judgment can be made regarding P_3. P_3 will accurately measure the social cost or benefit of a project only if the constraint causing the divergence between MSV and MSC is completely relaxed. But if such a relaxation is expected to occur, this is then the given state of the world in the context of which the project should be analyzed, i.e., P_1 and P_3 will coincide. If the relaxation is expected to occur at some point in time during the life of the project, then different P_1's should be used for the pre-relaxation, and the post-relaxation years.

If there is uncertainty as to whether a policy constraint will be maintained or relaxed, it would be useful to evaluate projects in terms of both P_1 and P_3. A hedging strategy would be to require projects to be socially profitable in terms of both of these shadow prices.

To sum up: of the three types of shadow price considered, only P_1 (which is, typically, a weighted average of MSV and MSC) correctly measures the social cost or benefit of producing or using a good in an investment project. The P_2 price is an internally inconsistent criterion, since it evaluates a good in accordance with its MSV in the presence of an existing policy constraint, yet measures opportunity cost correctly only if

...9/

the constraint can be relaxed. P_3 describes what values would be in a Utopian world in which welfare-maximising policies prevailed. In principle, therefore, its use is inappropriate for valuing goods in the existing world with its many imperfections.

Perhaps the most interesting point to emerge from the foregoing discussion is that the two shadow price concepts which appear superficially to be farthest removed from one another, viz, P_1 and P_3, often in practice provide substantially identical values: this is because P_1 is a weighted average of values that lie on either side of P_3. In a recent article, Bacha and Taylor noted that their preferred formula for calculating the shadow rate of foreign exchange (a P_3-type formula) resembled the Harberger-Schydlowsky-Fontaine shadow rate (a P_1-type formula).[5] However, they were at pains to stress the conceptual differences between the two formula, and suggested that the resemblance was "in some sense ..... coincidence".

It is not surprising that analysts generally have failed to recognize the conceptual similarities between P_1 and P_3 prices: in most cases shadow prices intended to conform to the P_1 concept have been loosely or incorrectly specified. The most sustained and consistent statement of the "ceteris paribus" approach to project evaluation so far produced is the UNIDO Guidelines for Project Appraisal.[6] However, in dealing with cases of divergence between MSV and MSC, the Guidelines usually considers only "either-or" situations: project output either represents a net addition

---

5. Edmar Bacha and Lance Taylor, "Foreign Exchange Shadow Prices: A Critical Review of Current Theories", Quarterly Journal of Economics, LXXXV:2 (May, 1971).

6. United Nations Industrial Development Organization, Guidelines for Project Evaluation (New York, 1972).

...10/

to total supplies, or it substitutes for existing output; inputs are either specially produced for the project or are diverted from alternative uses; and hence goods and services are to be valued either at their demand price or at their supply price (or marginal cost).[7] It is only with respect to foreign exchange that the Guidelines explicitly recognises that a shadow price is typically a weighted average of demand and supply prices.

---

7. "In every instance one must ascertain whether the physical output of a project adds to supply or substitutes for supply. In the first case, we identify the net output of the project as the actual physical output, and we proceed to measure the corresponding project benefits according to consumer willingness to pay for the goods and services produced. In the second case, we identify the net output of the project as being the resources previously used in the alternative source of supply of the same amount of physical output. .... Here we measure the corresponding project benefits according to consumer willingness to pay for the good and services released - or saved - by the project." - Guidelines, p.41.