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ON HOW TO INTERPRET AMBIGUOUS MARKET SIGNALS WHEN APPRAISING INVESTMENT PROJECTS

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The purpose of cost-benefit analysis is to compare, in a consistent and systematic way, the costs and benefits of a project, and to arrive at a meaningful measure of the project's net benefits, or of its internal rate of return. The heterogenous collection of physical inputs and outputs of the project are made comparable with one another by weighting each one according to a consistent set of unit values, or prices. The market prices which prevail in the country or region concerned are ordinarily used for this purpose: these are the prices to which both consumers and producers have to adapt in the course of their economic activities, so that the relative prices of two goods can be assumed, subject to certain assumptions, to represent their marginal rates of substitution in consumption, or in production, for each consumer or producer. Frequently, however, prevailing prices offer a poor, or an ambiguous guide to the social value of a good or service, and in such cases the cost-benefit analyst has to seek additional evidence in order to impute a value to the good or service. The nature of the additional evidence required will usually be obvious from the nature of the market distortion which leads one to reject the prevailing price as a measure of social value in the first place.

There are four principal types of situations where observed prices may be a misleading or ambiguous guide to social value. First, the price may not represent a market-clearing price, the good or service being allocated (rationed) on grounds other than consumers' willingness to pay for it: an overvalued exchange rate is perhaps the most obvious example. Second, production and/or consumption of the good or service may be attended by externalities, that is, costs are imposed or benefits given to parties not involved in the exchange relationship, such costs or benefits not being taken account of in the private costs of production or willingness to pay for the product. Third, there may be more than one market price, so that the question arises as to which, if any, of the prices appropriately measures the social value of the project output or input. Examples are legion: taxes and subsidies which drive a wedge between the supply price and the demand price; tariffs, which cause the domestic and the world prices to diverge; rural-urban wage differentials (other than "equalizing" differences); differences between the cost of capital in the private and

government sectors; and so on. Fourth, a monopolistically-determined price, while properly measuring a good's value-in-use, will overstate its cost of production.

I propose in what follows to consider the third type of situation, that is to discuss the principles of determining the social value of a project input or output for which more than one market price exists. Limitation of the discussion to this type of problem is not nearly so restrictive as it might appear. Most practical problems in project appraisal fall, I believe, into this category. Moreover, as will be seen, the analysis is applicable to the fourth (monoply) type of situation as well, and could probably be extended to cover the first (rationing) type of situation also.

An additional reason for considering this problem is the fact that contradictory advice concerning which of two prices to select in project appraisal has been offered by different analysts. For example, Little and Mirrlees recommend that, in evaluating industrial projects in underdeveloped countries, traded goods be valued at world prices (i.e., f.o.b. or c.i.f. prices for exports and imports respectively). Mishan disagrees, arguing that "the accounting prices of both additional imports and exports involved in any investment project .... are to be calculated by reference respectively to the subtraction from, and addition to, the country's domestic value; and not by reference to world prices of traded goods". Again, the Bank has established clear guidelines for the inclusion or exclusion of excise taxes and subsidies in the pricing of inputs and outputs, but at least one author has recommended practices which are the reverse of those adopted by the Bank.[1]

Excise Tax on the Output of a Project

An analytically-simple case with which to begin is that of a product subject to an excise tax

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1 Bank policy is to price all project inputs net of direct taxes ("because they do not constitute direct claims on physical resources"), but to include taxes in the price of outputs ("since they are part of the value for which buyers are willing to pay"). Subsidized resources are to be priced at their full economic cost, but subsidies are to be deducted from the benefit stream. (See *Operational Policy Memorandum*, March 31, 1971, No.2.21).

However, Richard S. Weckstein (I.B.R.D.-I.D.A. Economics Department Working Paper No.47, *Shadow Prices for Project Evaluation In Less Developed Countries*, June 1969) comes down in favour of usually including the excise tax in the shadow price of an input, but excluding it from the price of an output (see Weckstein, pp.16-17).

of fixed amount. Such a tax drives a wedge between the price paid by consumers and that received by producers: the former, or demand price, will exceed the latter, or supply price, by the amount of the tax. Suppose that the output of an investment project is a good (X) subject to such a tax: should the good be valued at its demand price (P^D) or at its supply price (P^S)?

The argument for using P^D is simply that the price paid by consumers represents their marginal evaluation of X, and since we are ultimately concerned with consumer welfare, this is also the proper social evaluation of the good. Account should be taken of course of any change in P^D likely to result from the increased supplies of X emanating from the project; that is, if the project is expected to have an appreciable impact on the total supply of X available to consumers, its price will be forced down to a greater or lesser degree, and the relevant P^D will be the mean of the P^D's that would prevail in the absence of, and in the presence of the project, respectively.[2]

Now this argument is valid so long as the whole of the project output of X represents a net addition to its total supply. However, there is an inconsistency in assuming both that this is the case and that the additional supply pushes down the price of the good: for if the latter occurs, there will, *ceteris paribus*, be some reduction in the quantity of X supplied by existing (i.e., non-project) producers. As a result, only part of the project output will represent a net addition to the total supply of X; the remainder will serve to displace some of the existing production of it. To the extent that this occurs, the value of the project output is not its value-in-use, but rather it is the value of additional production of other goods made possible through the release of resources previously committed to the production of X. And if the other goods are produced under conditions of no divergence between demand price and supply price, their value will be less than that of the X production displaced. Their value will, in fact, be equal to the cost savings arising from the cut-back in X-production by non-project producers, i.e., the supply price of X, suitably adjusted to take account of the fall in the price of X brought about by the increase in total supplies of X.

The argument can be clarified with the aid of Figure 1, in which DD represents the demand

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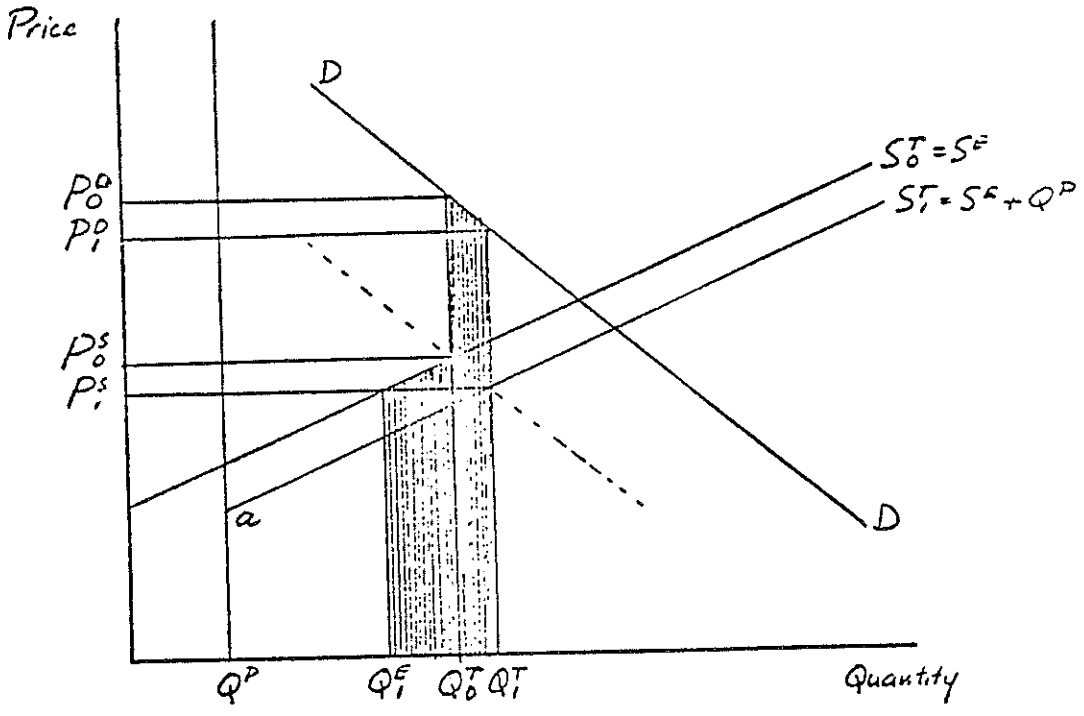
2 This assumes that the demand curve over the relevant interval is (approximately) linear.

Figure 1


Price
D
$S_0^T = S^E$
$S_1^T = S^E + Q^P$
P_0^D
P_1^D
P_0^S
P_1^S
a
D
Q^P
Q_1^E
Q_0^T
Q_1^T
Quantity

for a product, X, subject to an excise tax, t. A project is under consideration, the output of which is expected to be a quantity, Q^P, of X. The supply of X by existing producers is shown by the curve S^E, which is also the total supply prior to implementation of the project (period 0). The equilibrium output in period 0 is Q_0^T, consumers pay the price P_0^D and producers receive the price P_0^S, the difference between P_0^D and P_0^S being t. If the project is implemented, the supply curve shifts to the right by the amount of the project output, Q^P; thus the new supply curve is $Q^P aS_1^T$ and the new equilibrium quantity supplied in period 1 is Q_1^T, with corresponding equilibrium prices P_1^D and P_1^S. The total supply Q_1^T, is made up of Q_1^E, supplied by previously-existing suppliers, and Q^P supplied by the project. Note that Q_1^E is less than the amount of Q_0^T which existing suppliers produced before the project was implemented.

In assessing the value of the project's output of X, viz Q^P, we note that part of it, $(Q_1^T-Q_0^T)$ represents a net addition to the total supply of X. This increment to total supply is appropriately valued at the price which consumers are willing to pay for it, i.e., by the height of the demand curve over the interval Q_1^T Q_0^T. The total value of this increment is thus represented by the shaded area whose base is Q_C^T Q_1^T. The remainder of the project output, $Q_C^T-Q_1^E$, has served to displace an equivalent amount of X previously produced by existing suppliers. Assuming that the supply curve of the X-industry represents the sum of the marginal cost curves of the firms composing it, the value of the resources released through the cut-back in X-production is represented by the height of the supply curve over the interval Q_1^E Q_C^T, and hence the total value of these cost-savings is shown by the shaded area erected on the base Q_1^E Q_C^T. The two shaded areas combined represent the total value of the project output of X.

We conclude, therefore, that when the output of a project is subject to an excise tax, neither the price including tax, nor the price net of tax should be used to value the output, but, rather, that a weighted average of both should be used. The appropriate formula is $KP^D + (1-K)P^S$, where K is the proportion of project output which represents a net addition to total supply of the output. The magnitude of K will depend upon the relative slopes of the supply and demand curves over the relevant range. Also, account should be taken of the price-depressing effect of the increased total supply of the product on Q^D and Q^S.

In certain extreme cases it will be appropriate to assume K to have a value of 1, and in others, a value of zero, i.e., to value the entire output at either the demand or the supply price. If demand is perfectly elastic, or supply perfectly inelastic, existing production of the product will be unaffected by the marketing of additional supplies as a result of the project, and hence the latter should be valued at the demand price. If demand is perfectly inelastic, or supply perfectly elastic, the project output should be valued at the supply price, since it will serve only to displace existing production. Where either supply or demand is perfectly inelastic, the price-depressing effect of the project should also be taken into account.

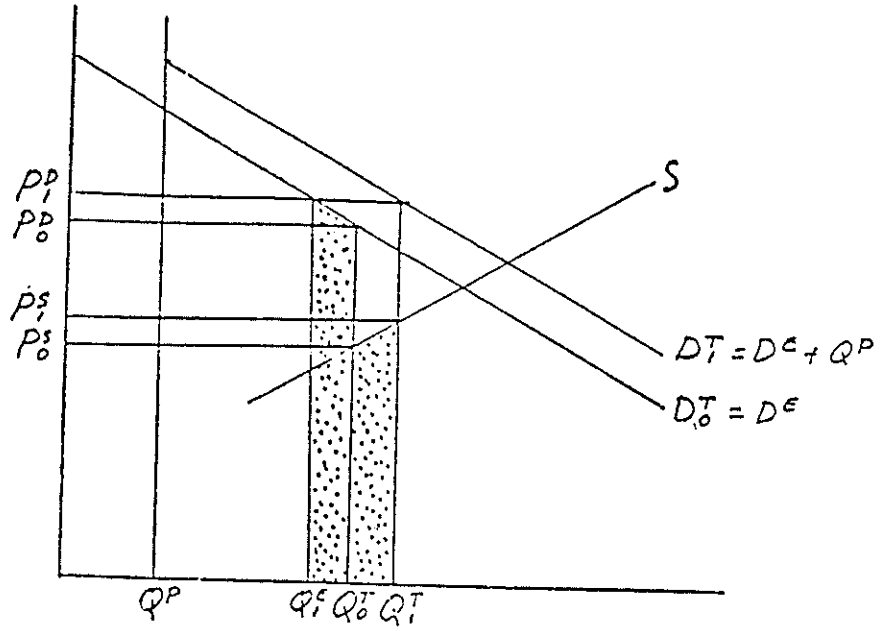
Although the preceding argument has been based on the assumption that the project's contribution to the total supply of this product is large enough to have a perceptible effect on the market price, it would be a mistake to assume that it is applicable only to such cases. Even if the project output is so small relative to the total supply that any effect on market price is expected to be too small to worry about, it can be assumed to have some effect, and the analysis remains valid. To put the point another way, even if the market price effect is negligible, we have no greater warrant for assuming, say, that all of the project output will represent a net addition to total supply than we have for assuming that none of it will.

Other Two-price Situations

Since the essential features of the analysis of a project output subject to an excise tax carries over to other two-price situations, we can consider them more cursorily.

The case of an excise tax levied on an input used in a project is shown in Figure 2. Here the amount of the input required by the project represents an addition to the total demand for that input. Hence the "with-project" demand curve for this input is the "without-project" curve shifted to the right by the amount of input required by the project. The new equilibrium price is higher, some aditional supplies of this input are produced (and are properly valued at the supply price) and there is some cut-back in the use of the input by previously-existing users. Insofar as the project competes supplies of the input away from previous users, they should be valued at the demand price, since this price reflects their productivity in alternative uses. As before, the appropriate price for valuing the input is a weighted average of P^D and P^S, except that here K is

Figure 2



Figures 3 and 4 represent situations where a subsidy is paid on project output, and on a project input, respectively. They are self-explanatory.

Figure 3

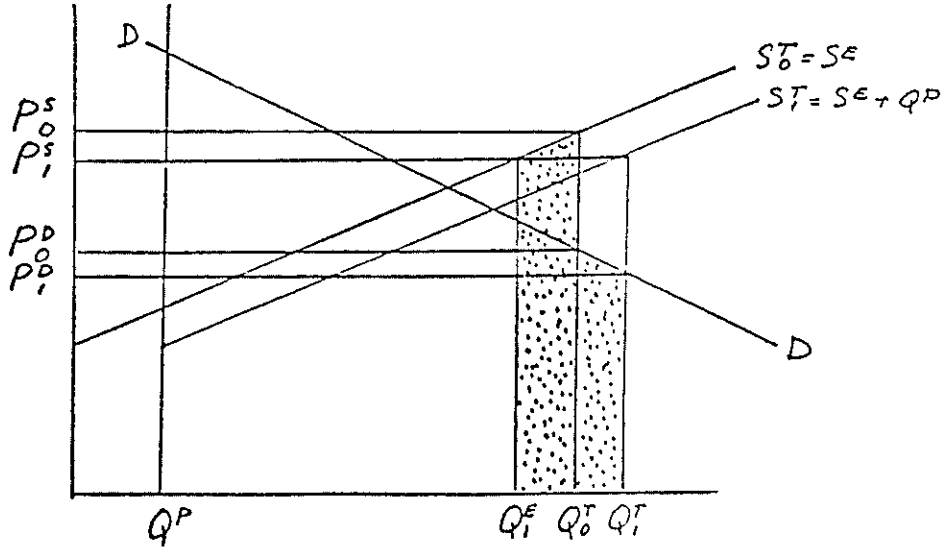
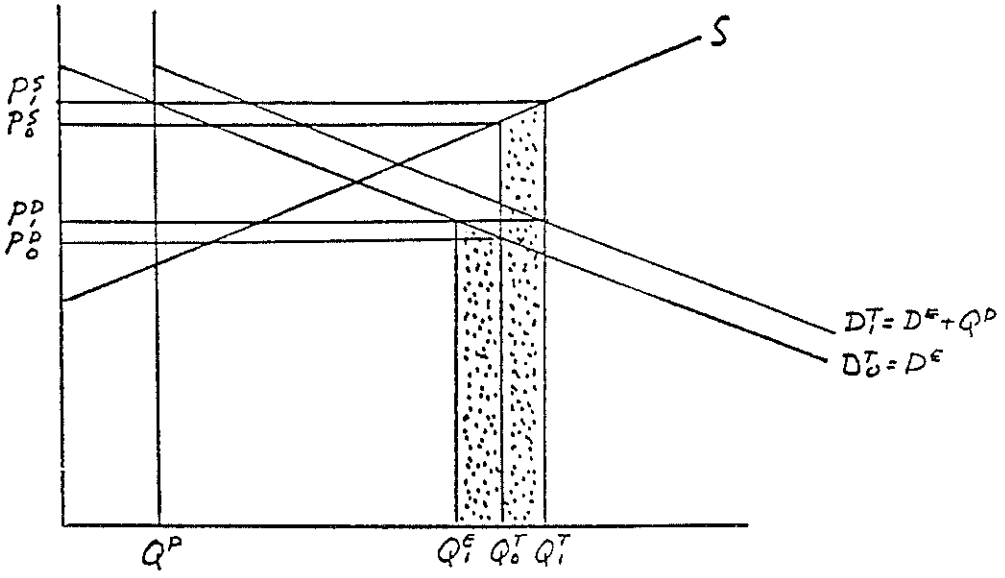


Figure 4



defined as the proportion of the project's requirement of the input which represents a net subtraction from the amount used by other enterprises.

Figure 5 analyses the case where existing production of a product which will be the output of a project is in the hands of a monopolist. The diagram is similar to Figure 1 except that the supply curve is replaced by the monopolists' marginal cost curve, and the impact of additional project-supplied output is shown by means of a leftward shift in the demand facing the monopolist. To the extent that the project output represents a net addition to total supply, it should be valued at the market price; to the extent that it displaces output previously supplied by the monopolist, it should be valued at the monopolist's marginal cost of production.

The case of a project input being supplied by a monopolist is shown in Figure 6. The demand facing the monopolist shifts to the right by the amount of the input required by the project. To the extent that increased production is elicited, the input should be valued at its marginal cost of production, which is less than the market price. To the extent that supplies are diverted from other users, it should be valued at its market price.

Other situations could be analyzed in the same vein, but the foregoing examples are more than adequate to demonstrate the general point, which is that any autonomous addition to (subtraction from) available supplies of a good will generally cause changes to occur both in the quantity demanded and in the quantity supplied. This is of course as true for an undistorted market situation, where demand price and supply price (or marginal costs) are equal, as for the distorted situations analyzed above. And, indeed, the fact that adjustment occurs on both the demand side and the supply side means that the price-depressing (price-raising) effects of the autonomous addition to (subtraction from) market supplies is less than it would be if it were restricted to one side or the other: this is a reason, reinforcing the usual pragmatic ones, for disregarding such price disturbances engendered by the implementation of investment projects. But, as was pointed out earlier, even if these price effects are, as a practical matter, disregarded, it is usually incorrect, in a two-price situation, to value output or input exclusively by reference to one or the other prices. The arguments that are usually advanced for selecting the higher or the lower price (for example, that an input should be valued at its price net of taxes, because taxes "do not

Figure 5

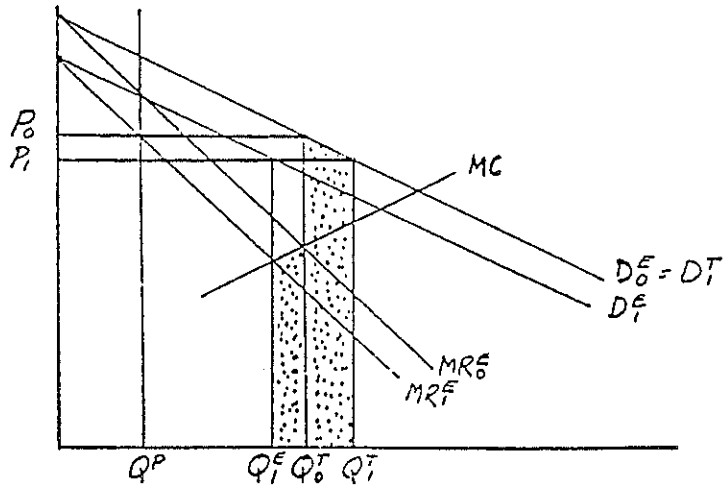
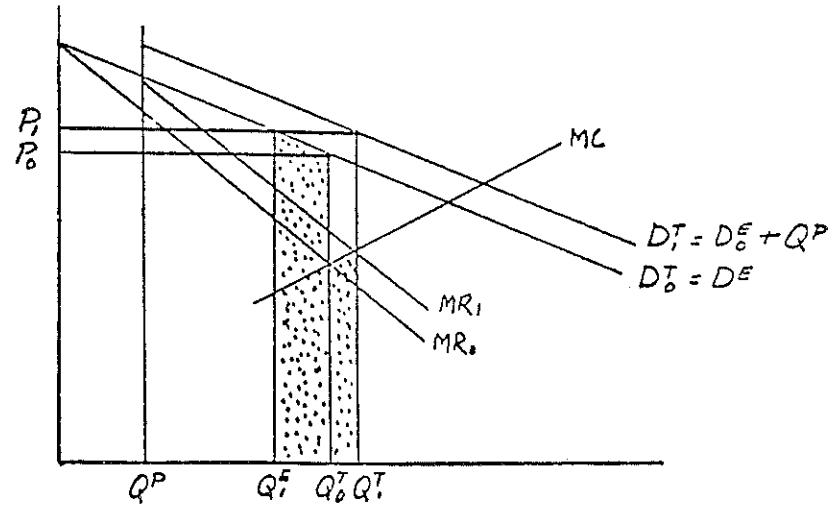


Figure 6



constitute direct claims on physical resources"; or that it should be valued at its tax-inclusive price, since this represents its value in alternative uses) while not invalid in themselves, are misleading because they rest on an incomplete analysis of the problem.

Some Qualifications

1. *"Second-Best" Situations*

Our analysis has been based on the assumption that the particular distortion under discussion is the only relevant distortion in the economy; or, more realistically, that it is a particularly large and obvious distortion which cannot be ignored in the same way that, as a practical matter, we ignore many minor distortions. In particular, it has been assumed that when adjustment occurs on the supply side, and resources are released from the industry to which the project belongs, they find employment in industries where marginal cost equals price, or where there is no divergence between the private and the social value of their marginal products. The same assumption is made concerning the value of resources drawn into an industry which produces a project input. Now this is a rather strong assumption, and it may be necessary to modify it in the light of knowledge of the economy as a whole, or of the particular resources concerned and their likely destination.

To take an extreme case, consider again the problem of valuing a project output subject to an excise tax, but suppose that a tax of similar proportions is levied on the products of those sectors of the economy where the released resources are likely to find employment. Then the value to consumers of the additiional output in these sectors will exceed its costs of production by the same proportion as the demand price exceeds the supply price in the initial industry, and it would be proper to value the released resources at an amount equal to the displaced production times its demand price, rather than times its supply price.[3]

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3 An interesting and probably fairly common special case of the above is where the released resources, or some of them, are absorbed by the project itself. According to the argument of this paper it would then be appropriate to value the whole of the project output at the demand price. However, it is also consonant with the general argument that, in considering the cost side of the project, the resources so absorbed be valued in opportunity cost terms, i.e., in terms of their social value productivity in their previous use. This will exceed their private productivity by a proportion equal to the rate of tax levied on the product. If, instead, they were valued at their money cost to the previous suppliers of the product, the profitability of the project would be

Seldom, however, will the nature of the required adjustment be ascertainable so simply as in the above example. More typically the analyst will be aware of or suspect the existence of many divergences in the economy between the social and the private value productivity of resources: the presence of monopolies, of monopsonies, of product taxes, will all cause the social value to exceed the private value; on the other hand, the existence of subsidies, or of sectors such as traditional agriculture (where workers received rewards in excess of the value of their marginal product) will have the opposite effect. In addition, positive and negative divergences will exist as a result of externalities. Some judgement will be required as to the balance of these conflicting tendencies in determining whether any adjustment is required (and, if so, how large an adjustment) to the supply price, or marginal cost of production, as a measure of the value of released resources.

2. *Corrective Taxes and Subsidies*

So far in our discussion it has been assumed that the divergence between demand price and supply price, with which we are concerned, is allocatively mischievous. However, some taxes, subsidies, etc. may, by design or accident, improve the pattern of resource use by correcting some distortion which would otherwise exist. For example, taxes may be levied, or subsidies paid, in order to bring home to producers and consumers the fact that production or consumption of the good concerned gives rise to external costs or benefits. The proper treatment of situations involving such corrective taxes or subsidies differs from that outlined above.

A tax (subsidy) which was wholly corrective would measure the marginal social external cost (benefit) associated with production and/or consumption of the taxed (subsided) good. Hence the social valuation of the good is the private, consumer evaluation of it minus the tax (plus the subsidy), which, of course, will be equal to the good's supply price. It would thus seem appropriate to value the project output or input of such a good at its supply price. This conclusion is correct so long as production or utilization of the good by the project gives rise to the same marginal external cost or benefit as does its existing production or consumption. But it is conceivable that

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overstated, and the outcome could be acceptance of a project which substituted project output for output which was already being supplied at lower cost.

when produced or consumed by the project, the good does not generate externalities,[4] in which case it is appropriate to value it at the demand price. To see why this is so, consider the case of a project output subject to a corrective tax. Insofar as the project output represents a net addition to the total amount consumed, it is appropriate to value it at the consumers' marginal evaluation, since the incremental production, by assumption, does not engender external costs. Insofar as it serves to displace existing production which does generate external costs, it is proper to value it at the supply price plus the tax, since not only are the private costs of production saved, but also the external costs imposed by the private production.

Similar arguments apply to the case of taxes which represent direct or indirect charges for the use of publicly-provided services, such as road taxes or gasoline taxes.

Pure corrective or user-charge taxes are rarely encountered, but many real-world taxes do contain corrective or user-charge elements. the same is true of subsidies and tariffs, except that almost invariably some ostensible social justification will have been provided for their existence. In all such cases, difficult - or, more likely, rough-and-ready - judgements will be required of the analyst as to how best to treat them.

Pricing of Traded Goods

A particularly important category of price distortion consists of those associated with government intervention in overseas trade. The imposition of tariffs, import restrictions, export taxes and subsidies, all bring about divergences between the domestic and the border prices of traded goods. In principle, the problems for project evaluation which are posed by the existence of separate domestic and border prices for traded goods are no different from those posed by other two-price situations such as have been discussed above. However, the analysis is a little more complicated.

Consider the case of an importable which is an input or output of a project and is subject to a tariff. Insofar as implementation of the project subtracts from or adds to the total supplies

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4 For example, coal might be taxed in order to discourage its use and so mitigate smoke nuisance, but the coal-burning project might utilize superior technology which eliminates smoke emission.

available to other domestic consumers and/or induces changes in the quantities produced by existing domestic producers of the good, it is appropriate to value the good at its domestic price (i.e., border price plus tariff). But insofar as the project's demand or supply of the good is accommodated through changes in the country's foreign exchange reserves - and assuming that a dollar's worth of foreign exchange is equivalent to a dollar's worth of domestic value added - the good should be valued at its border price.[5] To assume that the dollar value of foreign reserves measures their value in terms of domestic consumption foregone might be appropriate if we were dealing with an isolated tariff in an otherwise free-trade situation. More typically, however, we will be dealing with situations of more widespread intervention in foreign trade, in which case it will be necessary to multiply the border price by some shadow price for foreign exchange, in order to arrive at a more realistic estimate of the domestic value of additions to subtractions from exchange reserves. The procedure is thus exactly akin to that described earlier (see section headed "Second-Best Situations") where one of the two prices had to be adjusted to take account of other distortions in the economy.[6]

If implementation of the project were to result in significant additions to total supply or demand for the traded good, account must be taken, as in the cases analyzed previously, of any resulting changes in the world or domestic price. However, as far as changes in the world price are concerned, the treatment of traded goods differs from that outlined earlier. When the price of a non-traded good falls, the producers' loss of revenue is offset by an equivalent gain in consumers' surplus, but when the price of an export falls, the loss of revenue is a net loss to the country. Hence the social opportunity cost or benefit of marginal changes in imports or exports of

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5 Or, rather, its marginal import cost or marginal export revenue. (see next paragraph)

6 It should be noted that the conversion of foreign exchange into domestic value is the reverse of the procedure recommended by Little and Mirrlees in their *Manual of Industrial Project Analysis in Developing Countries.* Their procedure is to evaluate projects in terms of their contribution to foreign exchange earnings, i.e., to use foreign exchange rather than domestic value added as the numeraire. This involves them in converting the domestic value of non-traded goods into a foreign exchange equivalent by decomposing such goods into traded goods (valued at world prices) and the services of domestic factors of production (valued in terms of their marginal productivity in the production of foreign exchange earnings). This procedure would seem to be much more cumbersome, and probably no less subject to error, than that of adopting domestic value added as the numeraire and employing a shadow price for foreign exchange.

a traded good is not measured by the adjusted border price but by the adjusted marginal import cost or marginal export revenue. (For expositional convenience I propose for the remainder of this section to assume that the project demand or supply of the good is too small to affect significantly its border price, and hence will refer simply to the border price even though, in the general case, this phrase should be replaced by marginal cost or marginal revenue, as the case may be).

It was noted earlier that if the supply or the demand for a good subject to a tax or a subsidy is perfectly elastic, it is appropriate to value it solely in terms of its supply price or its demand price. Such extreme situations are far more likely to occur in the case of traded than non-traded goods: small countries frequently can be assumed to face extremely elastic demand curves for exports and supply curves for imports. Where this is the case - and provided the government's commercial policy permits the requisite changes in imports or exports to occur - the acquisition or sale of traded goods by a project will affect only the foreign exchange reserves of the country, domestic production and consumption of those goods remaining unaffected. Thus the social value of such "fully-traded" goods relative to one another is given by their border prices, and their value relative to non-traded or "partially-traded" goods is given by their border prices multiplied by the shadow price of foreign exchange. As a number of commentators have pointed out, it is only with respect to such fully-traded goods that Little-Mirrlees' recommendation that traded goods be valued at world prices directly applies.[7]

Where government intervention in overseas trade takes the form of direct controls, rather than such indirect instruments as tariffs, export subsidies, etc., calculation of the domestic value added or subtracted as a result of additional exports or imports involved in an investment project will require some knowledge of the types of control likely to be in force. For example, under a regime of effective import quotas, project demand for an import will be satisfied wholly at the expense of domestic consumption of the import, if the quota is not increased. The imported input should then be valued at its domestic price. Or the quota for this import might be enlarged but

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7 See Vijay Joshi, *The Little-Mirrlees Method of Project Selection*, Merton College, Oxford, May 1971 (mimeographed) pp.15-16. According to Heather Joshi (*The Rationale and Applicability of the Little-Mirrlees Method of Project Evaluation*, Institute of Economics and Statistics, Oxford University, (mimeographed) "fully-traded" goods were first defined by M.F.G. Scott in an unpublished OECD memorandum.

that for another contracted, in which case the cost of the input is the domestic value of the quantity of the other import foregone in order to pay for the first import. Or, again, the foreign exchange required to purchase the imported input may be obtained through a policy of increasing exports; then, the cost of the import is the domestic value of the reduced home consumption, or increased production, of the exported good.[8]

To summarize this section: in the general case, quantities of traded goods used in investment projects will come partly from increased domestic production, partly from decreased domestic consumption, and partly from increased imports or decreased exports. Similarly, quantities of traded goods produced by investment projects will serve partly to displace existing domestic production, partly to increase consumption, and partly to increase exports or decrease imports. Where the domestic and border prices of the good differ, the changes in domestic production and consumption are appropriately valued at the domestic price, and changes in imports and exports at the border price, appropriately adjusted so that it reflects the social opportunity cost of increased exports or the social benefit of increased imports. Hence a weighted average of the domestic price and the adjusted border price is the appropriate price for valuing the good for purposes of project evaluation.

Where the good is a "fully-traded" good, i.e., where project demand or supply of it serves only to increase imports or exports, its appropriate price is the adjusted border price. The same is of course true where there is no divergence between its domestic and border price.

The adjustment factor, i.e., the shadow price of foreign exchange, will itself typically be a weighted average of the domestic price of traded goods, relative to their border prices. However, in circumstances of detailed government control of foreign trade, the burden of adjustment may fall on a particular category or narrow range of traded goods, in which case it is the domestic value of goods, relative to their border prices, which constitutes the domestic value of foreign exchange.

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8 For a more detailed discussion of this topic, see E.J. Mishan's review of the Little-Mirrlees, *Manual* in *Canadian Journal of Economics*, IV:1 (February, 1971), pp.86-98.

Summary and Conclusion

The burden of this paper is the proposition that where two prices - demand price and supply price, or domestic price and border price - exist for an input or output of an investment project, typically neither one or these prices, but rather a weighted average of both, represents the true opportunity cost or social value of the quantities of the good involved in the project. This is because any autonomous addition to or subtraction from available supplies of a good will generally induce adjustments to be made both to the quantity demanded and to the quantity supplied, and, in the case of traded goods, both to domestic production and consumption and to overseas trade.

It follows that rules of thumb for project appraisal which specify that one or other of the prices alone should be used in valuing inputs and outputs are generally incorrect, though they may be correct in particular, extreme, instances. For example, adoption of the Bank's guidelines for the valuation of goods subject to taxes or subsidies will impart biases to cost-benefit appraisals since the profitability of projects involving taxed inputs and/or outputs will tend to be overstated, and that of projects involving subsidized inputs and/or outputs to be understated.

It also follows that the correct valuation of inputs and outputs for which more than one price exists requires a knowledge of the relevant supply and demand elasticities, and of any major relevant distortions in the economy concerned. Accurate information on these matters may be difficult or impossible to obtain, and the economist may have to make do with rough-and-ready "guesstimates". But, as Mishan has said apropos of his proposals for valuing traded goods, "he (the economist) is at least guessing at the magnitudes of the right things. And whenever the calculations that arise from using two alternative methods can be significantly different ... it is advisable to place reliance upon rough estimates of the relevant concepts than on more exact estimates of irrelevant ones."[9]

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9 *Ibid.*