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A NOTE ON THE DRC CRITERION

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A. *Introduction*

The domestic resource cost (DRC) criterion has been as important measure used to evaluate the international competitiveness of industries in LDCs where domestic prices are severely distorted.[1] However, in spite of its usefulness, there still remain several unsettled issues.[2] The DRC criterion for existing activities is one such issue.

Srinivasan and Bhagwati [12] suggested that the DRC for existing activities will be unity if the distorted situation has to be taken as given.[3] However, in the bulk of the project evaluation literature, their suggestion seems to have been largely neglected, and the DRC for existing activities has been calculated (see, for example, Sugimoto [13]). With this in mind, the central purpose of this note is to clarify the reasoning behind Srinivasan and Bhagwati's suggestion.

B. *Second-Best Shadow Factor Prices*

Let us consider the usual trade-theoretic model with two factors producing two traded commodities (scalars x_1 and x_2) that enjoy fixed international commodity prices.[4] The relationship between factors and commodities can be written as

$$AX=E \text{ or } X=A^{-1}E, \tag{1}$$

where A is an input coefficient matrix, while X and E are vectors of commodities and factors. The input coefficients are fixed when the domestic commodity price ratios are fixed.[5] Under such conditions,

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1 See, for example, Bruno [4], Balassa and Schydlowsky [1], and Krueger [6].

2 See, for example, the issues discussed by Lucas [8] [9], Pursell and Tower [11], and Lucas, Pursell, and Tower [10].

3 As will be shown in Sections C and D, if the considered project uses only labor (L) and capital (K), the project-acceptance criterion can be written as $w^*L+r^*K<p^*$, where p^*, w^*, and r^* are the world price of the project goods, the appropriate shadow wage and the appropriate shadow rent respectively. Thus, $\text{DRC}\equiv(w^*L+r^*K)/p^*$ is less than unity for the profitable project. However, when these shadow factor prices (w^* and r^*) are derived from $w^*L+r^*K=p^*$ using L, K, and p^* for existing activities, the index for existing activity is always unity.

4 Before Srinivasan and Bhagwati [12], Findlay and Wellisz [5] analyzed the concept of shadow price from the trade-theoretic viewpoint.

5 See, for example, Little and Mirrlees [7] and Bruno [2] [3].

$$\Delta X = A^{-1}\Delta E, \tag{2}$$

where Δ indicates the change in the values of variables.

On the other hand, the quantities of commodities evaluated at their international prices (scalar u) can be written as

$$u = P'X, \tag{3}$$

where P is a vector of international commodity prices and the mark (′) denotes the transpose. Thus, from equations (2) and (3),

$$\Delta u = P'\Delta X = (P'A^{-1})\Delta E. \tag{4}$$

Finally, the second-best shadow factor prices must equal the change in the quantities of commodities, evaluated at their international prices, resulting from a marginal change in the factors (ΔE) and maintaining the distorted commodity price ratio for production decisions. Thus, a vector of second-best shadow factor prices can be defined as

$$W' = P'A^{-1}. \tag{5}$$

C. *The DRC Criterion for the New Activities*

Let us consider the DRC of producing a unit of foreign exchange via the production of a new traded commodity (scalar x_z) in the project. Since the introduction of a project withdraws resources from the existing allocation, the change in factors available for existing activities can be written as

$$\Delta E = -a^Z, \tag{6}$$

where a^Z is the input coefficient vector of the new commodity.

Therefore, when the social opportunity cost (scalar SOC) associated with the project is measured by the products foregone,

$$\text{SOC} = -P'\Delta X = (P'A^{-1})a^Z. \tag{7}$$

On the other hand, the shadow factor cost (scalar SFC) associated with a project can be written as

$$\text{SFC} = W'a^Z. \tag{8}$$

In such a case, SOC = SFC because of equation (5).

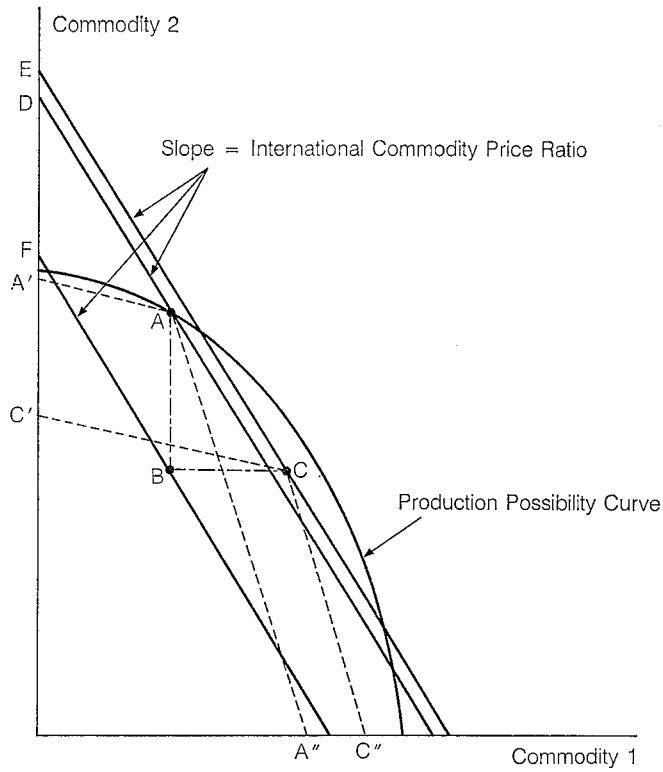
Since the international price of the new traded commodity is exogenously determined in the world market, the net revenue (NR) of this project does not necessarily equal zero. In other words, the DRC for the new activities does not necessarily equal unity.[6]

D. *DRC Criterion for the Existing Activities*

Let us consider the DRC of producing a unit of foreign exchange via the production of an existing traded commodity (scalar x_1) in the project. When commodity 1 increases by one unit, the following relationship can be obtained:

[6] For further explanation, see footnote 3 in Section A.

Fig. 1 Net Revenue of the Project



$$\Delta E = A\Delta X = A\ (1,\ \Delta x_2)', \tag{9}$$

where scalar $\Delta x_2 < 0$. Since the change in production of commodity 1 should not be included in the product foregone,

$$\text{SOC} = -\boldsymbol{P}'[\Delta \boldsymbol{X} - (1,0)'] = -p_2 \Delta x_2. \tag{10}$$

On the other hand,

$$\text{SFC} = \boldsymbol{W}'\boldsymbol{A}(1,0)' = \boldsymbol{P}'(1,0)' = p_1. \tag{11}$$

Thus, the NR based on the SOC does not generally equal zero while the NR based on the SFC always equals zero. The former concept has been motivating many project appraisers to calculate the DRC for existing activities.

The above discussion can be illustrated in Figure 1. Points A and C indicate the production points before and after the project respectively. (Since the distortional policy on the existing commodities is assumed to continue, the input coefficients are fixed. Therefore, the Rybczynski lines are parallel, i.e., AA′ // CC′ and AA″ // CC″.) This project increases the quantity of commodity 1 by BC = 1

TABLE I
EFFECTIVE RATE OF PROTECTION

	1980	1985
Food products	0.455	0.244
Textile products	0.363	0.009
Wooden products	0.459	0.052
Printing and publishing	0.126	0.009
Chemical products	0.331	0.027
Nonmetallic mineral products	0.474	0.065
Iron and steel	0.127	−0.005
Machinery	0.130	0.007
Miscellaneous manufacturing	0.503	0.018

Sources: Bank of Korea, *Input-Output Tables, Korea,* 1980 and 1985 editions.

and decreases the quantity of commodity 2 by AB. One of the shadow factor prices is also assumed to be negative. Thus, in terms of commodity 2, the appropriately evaluated product foregone is DF while the revenue is EF. In other words, on the basis of SOC, NR = ED >0.

E. *Some Empirical Results*

In the previous sections, the conceptual differences among the DRC criteria were examined. With this in mind, some empirical results using the DRC suggestion by Srinivasan and Bhagwati [12] are shown in this section.

1. *Korea's effective rate of protection (ERP)*

By using I-O tables, Korea's ERPs for different sectors can be measured.[7] The results are summarized in Table I. According to this, ERPs fell drastically in most manufacturing sectors during 1980–85. Moreover, the ERP of iron and steel changed from positive to negative. In other words, the economy became more "open" during this period. Thus, it is apparent that Korea's inward-looking (heavy industrialization) policies changed during this period.

2. *Role of technological changes*

These policy changes induced technological changes in the manufacturing sectors. Some of them were important, and the others were not. The DRCs suggested by Srinivasan and Bhagwati [12] can be utilized for such evaluation.

Table II shows the DRCs evaluated with the shadow prices of 1985.[8] Since the activities of 1985 are the "existing" activities, all the DRCs equal one as

[7] The ERP can be defined as ERP$=(v-v^*)/v^*$, where v^* and v are the value added per unit of final output at free-trade world prices and at domestic post-tariff prices. The former was estimated by using the tariff rates in the I-O tables.

[8] By using the I-O table for 1985, the shadow price (i.e., border price) of sector i (p_i^*) was derived from $p_i^*=p_i/(1+t_i)$, where p and t are the domestic output price and the import tariff rate. On the other hand, the shadow factor price (w_i^*) was calculated from

TABLE II

DRCs EVALUATED IN SHADOW PRICES OF 1985

	Activities of 1985	Activites of 1980
Food products	1.000	0.987
Textile products	1.000	0.989
Wooden products	1.000	0.998
Printing and publishing	1.000	0.999
Chemical products	1.000	0.998
Nonmetallic mineral products	1.000	1.009
Iron and steel	1.000	1.001
Machinery	1.000	1.001
Miscellaneous manufacturing	1.000	1.009

Source: Same as for Table I.

suggested by Srinivasan and Bhagwati [12]. However, since the activities of 1980 are different in 1985, their DRCs are not necessarily unitary. According to this, the DRCs of nonmetallic mineral products, iron and steel, machinery, and miscellaneous manufacturing are greater than one. In other words, if these industries had maintained the technologies of 1980, their net revenue would have been negative. Therefore, this suggests that the role of technological changes was important for these sectors.

F. *Conclusion*

In the bulk of the project evaluation literature, the SOC has been defined as appropriately valued products foregone. However, according to our examination, the SOC does not necessarily equal the SFC when the object of the project is to increase the production of existing industries. Thus, the NR calculated on the basis of the SOC does not equal zero, while the NR calculated on the basis of the SFC does equal zero as suggested by Srinivasan and Bhagwati [12].

This confusion is attributable to the difference in the treatment of underutilized factors induced by the project. Since the distortional policy on the existing commodities is assumed to continue, the domestic commodity price ratios are fixed. The input coefficients are also fixed. As a result, the project is possible only if some factors are left underutilized. In other words, as shown in Figure 1, the production point after the project must be located inside the production possibility curve.

This "surplus" of factors can be considered as a sort of "by-product" of the project. Therefore, when the shadow factor prices are positive, the benefit of the project will be greater than expected. In contrast, when one of the shadow factor prices is negative, the benefit of the project might be smaller than expected.

$w_i^* = p_i^* - a_{1i}p_1^* - \ldots - a_{ni}p_n^*$, where a_{ji} denotes the jth input coefficient. (For simplification, the I-O table was aggregated so that all the endogenous sectors became "tradable." Moreover, the primary factors were aggregated into one sector.) Then, the $\mathrm{DRC}_i = (w_i^* + a_{1i}p_1^* + \ldots + a_{ni}p_n^*)/p_i^*$ becomes unity. However, when these input coefficients are replaced by those for 1980, the DRCs are not necessarily unity.

With this in mind, the following definition of the net social opportunity cost, i.e., SOC – by-products, can be proposed in the framework of an n-commodity, n-factor model:

$$\begin{aligned}\text{NSOC} &= [-\boldsymbol{P}'(\Delta\boldsymbol{X}-\boldsymbol{M})] \ldots\ldots\ldots \text{products foregone} \\ &\quad -\{\boldsymbol{W}'[(-\Delta\boldsymbol{E})-\boldsymbol{N}]\} \ldots\ldots \text{surplus of factors} \\ &= \boldsymbol{P}'\boldsymbol{M}+\boldsymbol{W}'\boldsymbol{N}, \end{aligned} \tag{12}$$

where we have used the fact that $\boldsymbol{P}'\Delta\boldsymbol{X}-\boldsymbol{W}'\Delta\boldsymbol{E}=0$. Vector $\boldsymbol{M}$ becomes $(0..010..0)'$ when the project is to increase existing commodity J and $(0.....0)'$ when the project is to produce new commodity Z. Vector $\boldsymbol{N}$ becomes $(0.....0)'$ when the project is to increase existing commodity J and $\boldsymbol{a}^Z$ when the project is to produce new commodity Z.

Thus, when the project is to produce a new commodity, NSOC can be expressed as

$$\text{NSOC}=\boldsymbol{W}'\boldsymbol{N}=\boldsymbol{W}'\boldsymbol{a}^Z=\text{SFC}. \tag{13}$$

On the other hand, when the project is to increase an existing commodity J,

$$\text{NSOC}=\boldsymbol{P}'\boldsymbol{M}=\boldsymbol{P}'(0..010..0)'=p_j=\text{SFC}. \tag{14}$$

Therefore, the NR defined on the basis of the NSOC also becomes zero.[9] In other words, the confusion is attributable to whether the DRC concept is based on the SOC or the NSOC.

Finally, by using Korea's I-O tables, the usefulness of the DRC based on NSOC was shown. That is, even though the DRCs of existing activities are automatically one, evaluation of past or future technologies is possible. According to the empirical results, the role of technological changes in the heavy industries of Korea was shown to be important during 1980–85.

[9] Thus, it is clear that DE in Figure 1 does not indicate net revenue but indicates the appropriately valued surplus of factors. Since one of the shadow factor prices is negative, the net benefit of the project becomes smaller than expected.

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