Measuring the Comparative Advantage of Agricultural Activities: Domestic Resource Costs and the Social Cost-Benefit Ratio

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The Domestic Resource Cost (DRC) indicator is widely used in developing countries to measure comparative advantage and guide policy reforms. In this paper we demonstrate that the DRC formula is biased against activities that rely heavily on domestic factors (land and labor), and that a simple Social Cost-Benefit (SCB) ratio is a generally superior measure of social profitability. The SCB uses the same data as the DRC in a formula which does not distort profitability rankings. The policy significance of improved measurement is shown using data from Kenya, where the DRC overstates the relative profitability of activities using large amounts of tradable inputs.

Key words: agricultural policy, cost-benefit analysis, DRC.

Applied economists often wish to evaluate the comparative advantage of alternative activities, but they lack the data and other resources needed to construct a fully specified model of supply, demand, and trade.[1] In this context the contribution of alternative activities to aggregate growth can be compared through numerical indicators, the most prominent of which is the Domestic Resource Cost (DRC) ratio (Monke and Pearson, Tsakok). The DRC is widely used in academic research (e.g., McIntire and Delgado; Nelson and Panggabean; Nishimizu and Page; Weiss), but its primary use has been in applied work such as World Bank sector studies (e.g., World Bank, pp. 33–36) and policy analyses sponsored by other international agencies, including the Food and Agriculture Organization (Appleyard), International Maize and Wheat Improvement Center (Morris), International Food Policy Research Institute (Gonzales et al.), and the Organization for Economic Cooperation and Development (Alpine and Pickett). The limitations of the DRC relative to formal models that require more data are well documented (e.g., Tower 1992). In this paper, we show that the results of the DRC can be improved upon by using the exact same data in an alternative formula.

The DRC, defined as the shadow value of nontradable factor inputs used in an activity per unit of tradable value added, was developed simultaneously in the 1960s by Bruno and by Krueger. Bruno was seeking to measure the gain from expanding profitable projects, while Krueger wanted to measure the cost of maintaining unprofitable activities through trade protection. In both cases, they needed a ratio counterpart to the concept of net social profit. The DRC is only one of many possible ratios that could be used for such purposes, but little effort has been made to compare the index-number properties of alternative measures. Most analysts consider it sufficient to note that various indicators produce identical criteria for distinguishing between comparative advantage and disadvantage (e.g., Scandizzo and Bruce, p. 46; Monke and Pearson, p. 27). But policy makers often need to use indicators to rank alternative activities, or to identify a single most

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Senior authorship is not assigned. The authors would like to thank Scott Pearson, Jerry Nelson, and two anonymous referees for helpful suggestions.

[1] Following the tradition of cost-benefit analysis of trade policy (e.g., Corden), the terms "comparative advantage," "economic efficiency," and "social profitability" are used interchangeably, to reflect an activity's marginal contribution to GDP and growth.

Amer. J. Agr. Econ. 77 (May 1995): 243–250

desirable activity. Such rankings are not relevant in traditional trade theory, which implies that all desirable activities should be simultaneously expanded until further expansion is no longer desirable. But in many applications, policy makers cannot pursue all goals simultaneously. They therefore need priority rankings as well as a yes/no criterion.

In this paper we show that for any set of socially profitable activities, prioritizing alternatives based on the DRC may lead to selection of activities that do not offer the greatest possible contribution to economic growth. Because the DRC isolates the costs of domestic factors, it understates the social profitability of activities that make intensive use of these resources instead of tradable inputs. In contrast, the simple social cost/benefit (SCB) ratio produces activity rankings that are consistent with maximizing social profitability. In the next section we derive the DRC and SCB from a common model, and use that model to examine the sources of bias in the DRC and the rationale for using the SCB. In the final section we use data from Kenya to demonstrate the policy significance of using biased DRC rankings instead of the SCB.

Theoretical Properties of Alternative Indicators

Indicators like the DRC are constructed from average-cost budgets based on observed input-output coefficients and imputed shadow prices. Because the coefficients are observed under market prices rather than shadow prices, and because the shadow price of each budget item is calculated separately, the indicators ignore substitution and cross-price effects.[2] But the elasticities and other data needed to implement a more flexible model are often not available, so budget-based indicators remain widely used in policy debates, and the choice of indicator is of considerable practical importance.

Derivation of the DRC and SCB Criteria

The DRC and SCB formulas can be derived from a general production function, such as

$$Q_o = f(Q_d, Q_t) \text{ where } \frac{\partial Q_o}{\partial Q_i} > 0$$

and

$$\frac{\partial^2 Q_o}{\partial Q_i^2} < 0 \text{ for all } i = d, t.$$

In this formulation, output (Q_o) is a function of two composite inputs: domestic factors (Q_d) and tradable goods (Q_t). Not knowing the form or parameters of this function, we seek an indicator with which to rank a sample of observed activities in terms of their contribution to economic growth, at the prevailing set of social opportunity costs (P_o, P_d, P_t).[3] From the project appraisal literature (e.g., Gittinger, pp. 329–52), we know that to compare mutually exclusive alternatives, the ideal measure would be net social profits (NSP)

$$(1) \quad NSP(Q_o) = P_oQ_o - P_dQ_d - P_tQ_t.$$

To compare agricultural activities the NSP is less useful, because it is denominated in specific units with a physical *numéraire*, such as dollars per hectare or per ton of product. This makes it difficult to compare NSP values across different activities, so NSPs are only occasionally used in studies of agricultural comparative advantage (e.g., Tweeten). A unit-free ratio is generally preferred. Both the DRC and the SCB follow from expressing equation (1) as a ratio, to allow comparisons of disparate activities along a single normalized scale.[4]

To derive the DRC from (1), isolate P_dQ_d and divide both sides by tradable value added, $P_oQ_o - P_tQ_t$, to yield

[2] In some studies substitution effects are modeled by including multiple technologies and linking them through some estimated elasticity.

[3] The relationship between DRCs, shadow prices, and economic models is discussed in Srinivasan and Bhagwati; Lucas; and Tower (1984) among others. Useful rules of thumb for developing countries are presented in Monke and Pearson. In this paper we assume that the best available estimates of shadow prices are used.

[4] A more subtle problem with the NSP arises even when comparing activities on a common *numéraire*—say, a given type of land. Since the NSP is sensitive to the scale of the activity, adding more of all nonland inputs can raise the NSP even if these inputs could yield higher returns elsewhere. In such cases, adding inputs improves the NSP but worsens the DRC or SCB. Which indicator is correct depends on the supply of the underlying *numéraire* resource. The NSP is appropriate only if its supply is inelastic, such as a specific construction site, so that all activities are mutually exclusive. But farm activities are not generally constrained in this way, since additional resources can be drawn from other crops and farming methods. At the margin, the activity can be expanded at roughly constant costs, so the appropriate measure is a unit-free ratio such as the DRC or SCB. For a diagrammatic analysis of this issue, see Masters (1991), pp. 46–49.

$$(2)\qquad \frac{P_d Q_d}{P_o Q_o - P_t Q_t} = 1 - \frac{NSP(Q_o)}{P_o Q_o - P_t Q_t}.$$

The left-hand side of this equation is the DRC ratio. This particular normalization of equation (1) was originally developed in order to rank activities without estimating the shadow exchange rate. Both Bruno and Krueger estimated the shadow prices of domestic factors (P_d) in local currency and the shadow prices of output and tradable inputs (P_o and P_t) in foreign currency. Their "relative DRC" could be used to rank activities in terms of local currency costs per unit of foreign exchange earned or saved, but it could not distinguish efficient from inefficient activities without reference to the shadow exchange rate.[5]

In the quarter century since Bruno and Krueger developed the DRC, the calculation of shadow exchange rates has become a routine part of DRC analyses, and all costs are usually converted into a common currency (e.g., Srinivasan and Bhagwati). The resulting "absolute" DRC gives the same rankings as the "relative" measure, but incorporates the efficiency criterion as well. Activities that contribute to growth [$NSP(Q_o) > 0$] have DRC ratios between zero and one. Unprofitable activities [$NSP(Q_o) < 0$] have DRC ratios above one (or below zero, when the denominator is negative). "Break-even" activities have DRCs of one. Since the absolute version of the DRC combines the ranking and cut-off information, it is more widely used than the original relative version.

Given the use of a shadow exchange rate to convert all prices into a common currency, an alternative normalization of equation (1) would be to compare all costs with all benefits in a generalized social cost-benefit (SCB) ratio. Isolating all costs on the left-hand side and dividing by revenue, $P_o Q_o$, yields

$$(3)\qquad \frac{P_d Q_d + P_t Q_t}{P_o Q_o} = 1 - \frac{NSP(Q_o)}{P_o Q_o}.$$

The left-hand side of (3) is the SCB ratio. If net social profits are zero, the SCB (and the DRC) is one. As with the DRC, profitable activities have an SCB between zero and one, and unprofitable activities have an SCB greater than one. Unlike the DRC, however, the SCB cannot become negative. More importantly, it is not affected by the classification of costs as tradable or nontradable, which has been an empirically difficult aspect of DRC work—particularly when intermediate inputs such as transportation must be decomposed into tradable and nontradable components (Monke and Pearson, pp. 145–49).[6]

Avoiding classification errors is an important practical advantage of the SCB formula over the DRC, but a more fundamental advantage arises from the general index-number properties of the two indicators. These properties ensure that, even if all costs and benefits are correctly measured, the DRC will generally produce less accurate rankings of social profitability than the SCB.

Optimal Activities and Activity Rankings with the DRC and SCB Measures

The DRC and the SCB are alternative normalizations of the same profit identity. They use the same data and provide the same criterion for determining whether or not an activity is socially profitable. But they do not necessarily provide the same ranking of any two or more options. By comparing the conditions that obtain when optimizing based on the SCB and on the DRC, it can be shown that only the SCB ranking is consistent with the maximization of social profits.

For the general class of well-behaved production functions, activities that maximize net social profits from equation (1) will satisfy the following well-known optimality conditions:

$$\frac{\partial NSP(Q_o)}{\partial Q_i} = P_o f_{Q_i}(Q_d, Q_t) - P_i = 0 \qquad i = d, t.$$

In terms of factor intensity, the ratio of marginal products must equal the input price ratio

$$(4)\qquad \frac{f_{Q_t}(Q_d, Q_t)}{f_{Q_d}(Q_d, Q_t)} = \frac{P_t}{P_d}.$$

To determine the accuracy of SCB rankings relative to this familiar benchmark, we can examine the first-order conditions associated with choosing activities that minimize SCB

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[5] Bruno noted that DRC rankings might not correspond exactly to a net profit ranking (footnote, p. 115), and Warr proved this proposition explicitly. The purpose of this paper is to clarify the bias in the DRC, and demonstrate the accuracy of an alternative ratio.

[6] Like the DRC or any cost-benefit ratio, the SCB will be affected by the classification of costs as negative benefits.

$$\frac{\partial SCB(Q_o)}{\partial Q_i} = \frac{P_o f(Q_d,Q_t)P_i - (P_dQ_d + P_tQ_t)[P_o f_{Q_i}(Q_d,Q_t)]}{[P_o f(Q_d,Q_t)]^2} = 0$$

$$i = d,\ t.$$

Combining the two first-order conditions and simplifying gives

$$\frac{f_{Q_t}(Q_d,Q_t)}{f_{Q_d}(Q_d,Q_t)} = \frac{P_t}{P_d}$$

which is the original optimality condition found in equation (4). Hence, activities with minimum SCB have the same factor intensity as those which maximize social profits.

The basic factor-intensity condition expressed in (4) does not obtain for activities with the lowest DRC. The first-order conditions associated with the minimum DRC are

$$\frac{\partial DRC(Q_o)}{\partial Q_t} = \frac{-(P_dQ_d)[P_o f_{Q_t}(Q_d,Q_t) - P_t}{[P_o f(Q_d,Q_t) - P_tQ_t]^2} = 0$$

and

$$\frac{\partial DRC(Q_o)}{\partial Q_d} = \frac{[P_o f(Q_d,Q_t) - P_tQ_t]P_d - P_dQ_d[P_o f_{Q_d}(Q_d,Q_t)]}{[P_o f(Q_d,Q_t) - P_tQ_t]^2} = 0$$

Simplifying these two equations yields

$$P_o f_{Q_t}(Q_d,Q_t) = P_t$$

and

$$P_o f_{Q_d}(Q_d,Q_t) = \frac{P_o f(Q_d,Q_t) - P_tQ_t}{P_dQ_d} P_d.$$

Combining the two first-order conditions and substituting the definition of DRC [equation (2)] reveals

$$(5)\qquad \frac{f_{Q_t}(Q_d,Q_t)}{f_{Q_d}(Q_d,Q_t)} = \frac{P_t}{P_d} DRC.$$

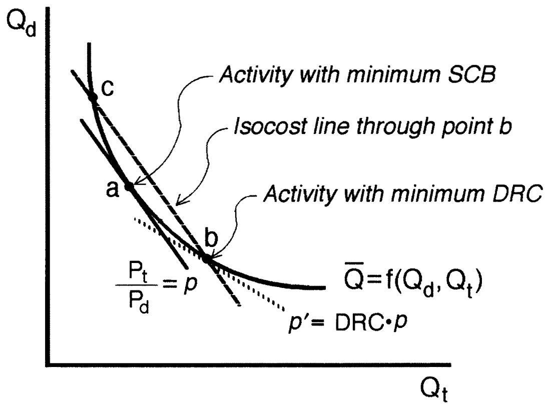

Figure 1. Optimal activities with the DRC and SCB measures

Equation (5) is consistent with the basic condition in (4) only when DRC equals one. In general, when using the DRC measure, the highest-ranked activity will have a ratio of marginal products of inputs that is not equal to their relative prices, and therefore does not necessarily maximize social profits. If the highest-ranked activity has a DRC below one, there might exist a more efficient activity which would substitute additional domestic factors (Q_d) for tradable inputs (Q_t). Such an activity would be correctly identified by the SCB. Thus, using the DRC to rank activities leads to overly intensive use of tradable inputs, and is inconsistent with maximizing social profits. The SCB is not subject to this bias, and correctly indicates socially optimal levels of input use.[7]

A diagrammatic view of the optimality conditions given in equations (4) and (5) is shown in figure 1. Along an isoquant drawn for any well-behaved production function, the technique with the lowest SCB is indicated by point "a" [the point of tangency with an isocost line of slope $p = P_t/P_d$, following equation (4)], while the technique with the lowest DRC is indicated by point "b" [the point of tangency with a line of slope $p' = DRC{\cdot}P_t/P_d$, following equation (5)]. Since point "a" is indeed the lowest-cost technique, the SCB rule corresponds to cost-

[7] The DRC does indicate which activities produce the highest return to domestic factors, but this corresponds to profit-maximization only if domestic factors are fixed in supply. While their aggregate supply may be limited, land and labor can move between activities, so the supply of domestic factors to individual farm activities is not fixed; as long as the opportunity cost of domestic factors is captured by their shadow prices, the SCB provides a better budget-based indicator of social profitability than the DRC. This holds even if opportunity costs are defined to make only one activity appear socially profitable.

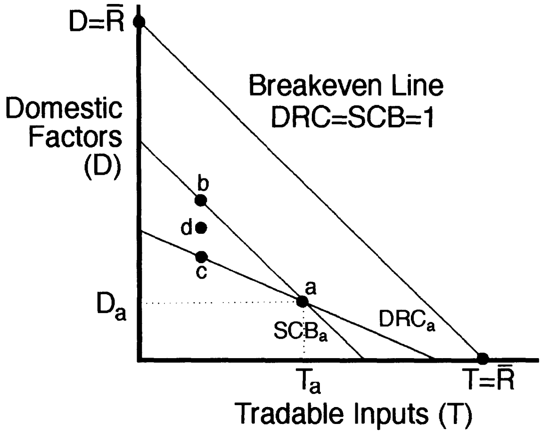

Figure 2. Activity rankings with the DRC and SCB measures

minimization and profit-maximization, while the DRC rule does not.

From equations (4) and (5) and the corresponding figure 1, we can infer that the prevalence and direction of DRC ranking errors will be determined by each activity's use of tradable, as opposed to nontradable, inputs. An activity such as "b" will be incorrectly ranked by the DRC as more profitable than any activity along the arc between "b" and "c". The length of this arc, and hence the number of activities incorrectly ranked relative to "b," depends on the position of "b" along the isoquant. By construction, the higher the percentage of tradable inputs in the costs of a profitable activity, the greater the likelihood of the DRC overstating that activity's profitability relative to some other technique.

Another perspective on the relationship between input-intensity and DRC errors is given in figure 2, which shows the total value of domestic factors (P_dQ_d, denoted D) and tradable inputs (P_tQ_t, denoted T) used to produce a given level of revenue (P_oQ_o, denoted $\bar{R}$).[8] In figure 2, all iso-cost lines have a slope of -1; an example is the "break-even" line going from upper left to lower right, along which total costs ($D + T$) exactly equal revenues ($\bar{R}$) so profits are zero and the DRC and SCB ratios equal one. To find the range of activities in which DRC rankings are incorrect we need also to calculate "iso-DRC" and "iso-SCB" lines.

[8] The diagram in figure 2 is less familiar than that of figure 1, but is convenient for analyzing the index-number properties of many policy indicators. A similar diagram is used in Masters (1993) to discuss the Producer Subsidy Equivalent (PSE) measure.

These can be derived relative to an arbitrary activity such as point "a," which uses D_a and T_a to produce revenue $\bar{R}$. The DRC and SCB levels for this activity can be expressed as

$$DRC_a = \frac{D_a}{\bar{R} - T_a} \quad (6)$$

and

$$SCB_a = \frac{D_a + T_a}{\bar{R}}. \quad (7)$$

Since revenues are fixed at $\bar{R}$, we can rearrange terms to find the locus of combinations of D and T that have the same DRC and SCB values as activity "a." These iso-DRC and iso-SCB lines are defined by the following equations:

$$D_a = DRC_a\bar{R} - DRC_aT_a \quad (8)$$

and

$$D_a = SCB_a\bar{R} - T_a. \quad (9)$$

Thus a line through point "a" with the slope of minus DRC_a captures the set of all activities sharing DRC_a, while a line through point "a" with a slope of minus one traces the set of activities with SCB_a. Since the iso-SCB line is also an iso-cost line, it correctly discriminates among activities that are more profitable than "a" (below the SCB_a line) or less profitable (above the SCB_a line).

Ranking errors will arise from the DRC when activity "a" is compared to any activity between SCB_a and DRC_a. An example would be activity "d," which has a higher DRC than "a" (because it lies above "c" on DRC_a) but a lower SCB (because it lies below "b" on SCB_a). As the DRC deviates further from one, the area of potential ranking conflicts expands. Moreover, increases in the difference of the tradable input shares of any two activities (say "a" and "d") increase the probability of a ranking error.

We can conclude from equations (4) and (5) and the corresponding figures that DRC rankings tend to overstate the relative profitability of activities that make intensive use of tradable inputs, and that the frequency of misranking will be related to the degree of input-intensity. This bias in the DRC is particularly important for developing countries, where extremely land- or labor-intensive "traditional" farming systems often coexist with more "modern" production methods that use tradable inputs intensively. Using the DRC in this context will consistently understate the social profitability of the domestic factor-intensive traditional systems, and exaggerate the social gain from using herbicides and mechanical equipment to substitute for labor, as well as the gain from using fertilizer and other inputs to substitute for land. Such misrankings are caused not by mismeasurement of the shadow prices or input/output coefficients, but by the construction of the DRC formula.

Policy Significance of Bias in the DRC: The Example of Kenya

An empirical demonstration of the bias in the DRC is provided in data (from Pearson and Monke) on thirty-one agricultural systems in five districts of Kenya. These data confirm the expected link between DRC ranking errors and tradable input use, and demonstrate the practical importance of using the SCB.

DRC and SCB Results for Kenya

The sample of cropping systems was drawn from three broad classes of crops all grown in areas of high agricultural potential: cereals, traditional export crops, and horticultural crops. The traditional exports were introduced in the colonial period, while the horticultural products are now being promoted as new cash cropping alternatives. The horticultural crops are the most dependent on tradable intermediate inputs (41% of total costs on average, as opposed to 24% for cereals and 16% for traditional exports). Although some of these crops have particular agro-ecological requirements, there is generally an elastic supply of land and labor for expanding production of each crop at the expense of other crops (Winter-Nelson). Hence, a unit-free ratio is the appropriate measure of their relative profitability.

Table 1 lists the DRC and SCB level and rank order for each production system. The DRC favors the tradable-input-intensive wheat and horticultural crops, relative to more labor-intensive maize and traditional export crops. The DRC approach incorrectly ranks two of the mechanized wheat systems 2nd and 7th (above most maize systems), while the SCB ranks them 19th and 24th. Similarly, some horticultural crops using substantial intermediate inputs are ranked too high using the DRC: cabbages and potatoes are ranked 10th and 11th by the DRC, but are 16th and 22nd with the SCB. Meanwhile the DRC incorrectly understates the relative profitability of maize and traditional export crops which require more labor. None of the traditional export crops are in the top twelve under the DRC, but the SCB puts three (coffee, cotton, and pyrethrum) in the top dozen.

The difference between any activity's ranks under the DRC and the SCB can be used to quantify the degree to which the DRC misranks that activity. An activity's "ranking error" (defined as its SCB rank minus its DRC rank) gives the number of other activities which were incorrectly ranked as less profitable than that activity by the DRC. Characteristics of the DRC highlighted in figures 1 and 2 suggest that such ranking errors are positively correlated with each activity's use of tradable inputs; that hypothesis is sustained by a high degree of correlation between ranking errors and tradables' share of total costs. The simple correlation coefficient is over 70%; by OLS regression, a 10% greater cost share for tradables was found to be associated with a change of 2.8 places in the activity rankings.[9] Variation in cost shares is clearly responsible for major deviations in DRC rankings from rankings of social profitability.

Ranking errors such as those found in this study are important to public policy because Kenya's agricultural sector strategy is based in part on indicators of social profitability, with a range of public-sector investments being used to support expansion of crops that are perceived by policy makers and aid donors to be economically efficient. Many of the horticultural crops are unambiguously superior to other production choices; the same four horticultural crops rank in the top five under each method of analysis. Nonetheless, the DRC indicator consistently exaggerates the comparative advantage of horticultural crops and wheat and understates the contribution of maize and traditional export crops. Relying on the DRC creates the false impression that traditional food and export crops contribute little to economic

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[9] The OLS regression results are

$$\textit{Ranking Error} = -8.28 + 27.8 \times \textit{Tradable Cost Share}$$

where each activity's Ranking Error is defined as its SCB rank minus its DRC rank, and its Tradable Cost Share is defined as in table 1. The correlation coefficient (R-squared) is 0.725, and the t-statistic on the cost share coefficient is 8.74.

Table 1. DRC and SCB Indicators for Kenya, 1990 Harvest

Cropping Activity				SCB		DRC	
Class[a]	Crop[b]	District	Cost Share[d]	Value	Rank	Value	Rank
H	French beans	Kakamega	0.37	0.20	1	0.14	4
H	Irrig. tomato	Nyeri	0.47	0.20	2	0.12	3
H	Oranges	Nakuru	0.52	0.22	3	0.10	1
H	Canning tomato	Nakuru	0.37	0.23	4	0.15	5
C	Maize-beans	Kisii	0.26	0.24	5	0.19	6
H	Improved tomato	Nakuru	0.32	0.31	6	0.21	8
TE	Coffee	Kisii	0.01	0.33	7	0.33	13
TE	Cotton	Siaya	0.10	0.35	8	0.33	14
C	Wheat	Nyeri	0.45	0.37	9	0.25	9
C	Maize-beans	Siaya	0.19	0.40	10	0.36	18
C	Maize-beans	Kakamega	0.24	0.40	11	0.34	15
TE	Pyrethrum	Kisii	0.02	0.41	12	0.40	22
C	Maize	Nyeri	0.25	0.41	13	0.34	16
C	Maize-beans	Nakuru	0.23	0.41	14	0.32	12
TE	Pyrethrum	Nakuru[c]	0.01	0.42	15	0.42	24
H	Irrig. cabbage	Nyeri	0.54	0.43	16	0.25	10
C	Maize, tractor	Nakuru[c]	0.28	0.43	17	0.35	17
TE	Tea	Nyeri	0.23	0.43	18	0.37	19
C	Large-sc. wheat	Nakuru	0.73	0.45	19	0.12	2
H	Rainfed tomato	Nyeri	0.27	0.47	20	0.39	21
C	Maize-beans	Nyeri	0.30	0.47	21	0.38	20
H	Rainfed potato	Nyeri	0.56	0.49	22	0.29	11
TE	Pyrethrum	Nakuru	0.01	0.52	23	0.52	26
C	Wheat	Nakuru	0.64	0.54	24	0.23	7
C	Maize, ox-plow	Nakuru[c]	0.18	0.58	25	0.53	27
H	Rainfed tomato	Nakuru	0.26	0.60	26	0.44	25
C	Improved sorghum	Siaya	0.11	0.62	27	0.59	30
H	Rainfed potato	Nakuru	0.22	0.62	28	0.56	28
H	Irrig. potato	Nyeri	0.61	0.64	29	0.40	23
TE	Tea	Kakamega	0.22	0.82	30	0.78	31
TE	Estate coffee	Nakuru	0.28	0.82	31	0.59	29

Note: All figures are calculated from data in Pearson and Monke.
[a] H, horticultural; C, cereal; TE, traditional export.
[b] An additional five activities were ranked 32-36 by both measures. Cropping systems are for smallholder production unless otherwise noted.
[c] Upper elevation areas of the district.
[d] Tradable costs over total costs.

growth, whereas using the SCB gives a more accurate view of their relative social profitability.

Conclusions

In typical agricultural settings, rankings of social profitability based on domestic resource cost (DRC) ratios are biased against activities that use few tradable inputs, such as more traditional land- and labor-intensive farming systems. In general, the social cost/benefit (SCB) ratio provides more accurate rankings of the comparative advantage of alternative activities. The use of a DRC may be justified only when the shadow exchange rate cannot be estimated, but the potential bias in the DRC should be acknowledged. As long as a shadow exchange rate is estimated, the SCB is clearly superior. Evidence from Kenya demonstrates the expected relationship between DRC and SCB rankings and illustrates the importance of using the SCB when comparing activities that have very different input combinations.

[Received March 1994; final revisions received October 1994.]

References

Alpine, R.W.L., and J. Pickett. *Agriculture, Liberalisation and Economic Growth in Ghana and Cote d'Ivoire, 1960-1990.* Paris: OECD Development Centre, 1993.

Appleyard, D. *Comparative Advantage of Agricultural Production Systems and its Policy Implications in Pakistan.* Development Paper No. 68, Food and Agriculture Organization, Rome, 1987.

Bruno, M. "The Optimal Selection of Export-Promoting and Import-Substituting Projects." *Planning the External Sector: Techniques, Problems and Policies.* Report on the First Interregional Seminar on Development Planning, Ankara, Turkey, 6-17 September 1965, Document ST/TAO/SER.c/91, pp. 88–135. New York: United Nations, 1967.

Corden, W.M. *Trade Policy and Economic Welfare.* Oxford UK: Clarendon Press, 1974.

Gittinger, J.P. *Economic Analysis of Agricultural Projects,* 2nd ed. Baltimore MD: John Hopkins University Press, 1982.

Gonzales, L.A., F. Kasryno, N.D. Perez, and M.W. Rosegrant. *Economic Incentives and Comparative Advantage in Indonesian Food Crop Production.* Research Report No. 93. International Food Policy Research Institute, Washington DC, 1993.

Krueger, A.O. "Some Economic Costs of Exchange Control: The Turkish Case." *J. Polit. Econ.* 74(October 1966):466–80.

Lucas, R.E.B. "On the Theory of DRC Criteria." *J. Develop. Econ.* 14(April 1984):407–17.

McIntire, J., and C.L. Delgado. "Statistical Significance of Indicators of Efficiency and Incentives: Examples from West African Agriculture." *Amer. J. Agr. Econ.* 67(November 1985):733–38.

Masters, W.A. "Comparative Advantage and Government Policy in Zimbabwean Agriculture." PhD Dissertation, Food Research Institute, Stanford University, 1991.

___. "Measuring Protection in Agriculture: The Producer Subsidy Equivalent Revisited." *Oxford Agr. Stud.* 21(November 1993):133–42.

Monke, E.A., and S.R. Pearson, eds. *The Policy Analysis Matrix for Agricultural Development.* Ithaca NY: Cornell University Press, 1989.

Morris, M.L. *Determining Comparative Advantage Through DRC Analysis: Guidelines Emerging from CIMMYT's Experience.* CIMMYT Economics Paper No. 1, Mexico City, Mexico, 1990.

Nelson, G.C., and M. Panggabean. "The Costs of Indonesian Sugar Policy: A Policy Analysis Matrix Approach." *Amer. J. Agr. Econ.* 73(August 1991):703–12.

Nishimizu, M., and J. Page, Jr. "Productivity Change and Dynamic Comparative Advantage." *Rev. Econ. and Statist.* 68(May 1986):241–47.

Pearson, S.R., and E.A. Monke. *Agricultural Growth in Kenya: Applications of the Policy Analysis Matrix.* Ithaca NY: Cornell University Press, forthcoming.

Scandizzo, P.L., and C. Bruce. *Methodologies for Measuring Agricultural Price Intervention Effects.* World Bank Staff Working Paper No. 394. Washington DC, 1980.

Srinivasan, T.N., and J.N. Bhagwati. "Shadow Prices for Project Selection in the Presence of Distortions: Effective Rates of Protection and Domestic Resource Costs." *J. Polit. Econ.* 86(February 1978):97–116.

Tower, E. *Effective Protection, Domestic Resource Costs, and Shadow Prices.* The World Bank, Staff Working Paper No. 664 Washington DC, 1984.

___. "Domestic Resource Cost." *J. Int. Econ. Integration* 7(1992):20–44.

Tsakok, I. *Agricultural Price Policy: A Practitioner's Guide to Partial Equilibrium Analysis.* Ithaca NY: Cornell University Press, 1990.

Tweeten, L. "Impact of Domestic Policy on Comparative Advantage of Agriculture in the South." *S. J. Agr. Econ.* 18(July 1986):67–74.

Warr, P.G. "The Domestic Resource Cost as an Investment Criterion." *Oxford Econ. Pap.* 35(1983):302–6.

Weiss, J. "An Application of the Domestic Resource Cost Indicator to Mexican Manufacturing." *Indust. and Develop.* 29(1991):63–78.

Winter-Nelson, A. "Nakuru District: Growth in a High Potential, Small and Large Farm District." *Agricultural Growth in Kenya: Applications of the Policy Analysis Matrix.* S.R. Pearson and E.A. Monke, eds. Ithaca NY: Cornell University Press, forthcoming, chap. 6.

World Bank. "Zimbabwe Agricultural Sector Memorandum." Report No. 9429-ZIM. Washington DC, 1991.