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Evaluating the Economic Efficiency of Agricultural Activities in Developing Countries: Domestic Resource Costs and the Social Cost–Benefit Ratio

Abstract: This paper demonstrates that the conventional Domestic Resource Cost (DRC) indicator is biased against factor-intensive, low-input techniques, and that a simple Social Cost–Benefit (SCB) ratio is generally a more appropriate measure of economic efficiency. The potential policy significance of improved measurement is shown with data from Zimbabwe and Kenya. In Zimbabwe, the DRC is shown to incorrectly rank high-input large-scale farming systems above more labour-intensive smallholder systems; in Kenya, the DRC incorrectly ranks high-input horticultural crops above more labour-intensive food grains and traditional export crops.

INTRODUCTION

During the 1980s the Domestic Resource Cost (DRC) became a standard measure of economic efficiency used in developing countries, has been prescribed in texts, used in academic research, and in policy studies for FAO CIMMYT, IFPRI, OECD; (World Bank, 1984a, 1984b; Monke and Pearson, 1989; Tsakok, 1989; Nelson and Panggabean, 1991; Williams, 1992; Appleyard, 1987; Morris, 1988; Gonzales *et al.*, 1993; Alpine and Pickett, 1993).

In this paper it is shown that the DRC is often significantly biased and should generally be replaced with a broader social cost–benefit (SCB) ratio, using exactly the same data but in a different formula. The bias in the DRC arises because it exaggerates the costs of domestic factors relative to tradeable inputs. In particular, it understates the profitability of land and labour-intensive smallholder farming, relative to more input-intensive activities. The SCB ratio treats all costs equally, which eliminates this bias.

The DRC ratio was originally developed for use where there was no shadow exchange rate at which to convert the values of non-tradeable and tradeable goods into a common currency. The fundamental rationale for the DRC was that the shadow prices of tradeables and non-tradeables were denominated in different currencies, and therefore must be kept separate (Bruno, 1978; Krueger, 1966). But in the intervening 25 years, considerable progress has been made in estimating shadow exchange rates. Today, they can be measured at least as accurately as the shadow prices for labour, land, capital or other domestic factors. Where a shadow exchange rate has been measured, the fundamental justification for using DRCs is lost and the more general SCB ratio is more appropriate.

To construct measures of economic efficiency such as the DRC or SCB, the input and outputs for each activity must be valued at their economic opportunity cost or shadow price, which is found in the international market for traded goods, and in the domestic market for non-tradeables (Srinivasan and Bhagwati, 1978; Tower, 1984; Dręze and Stern, 1987; Monke and Pearson, 1989). It is assumed here the best available estimates of shadow prices are used, to focus on the appropriate ratio with which to value farm activities.

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For a given set of budget data and estimated economic opportunity costs, the DRC exaggerates the cost of domestic factors such as land and labour, as opposed to tradeable inputs. This leads the DRC to discriminate against factor-intensive activities, which is particularly important in developing countries where use of the DRC consistently understates the contribution of traditional smallholder farming systems relative to more 'modern' input-intensive production. The DRC exaggerates the benefits of using herbicides and mechanical equipment to substitute for labour, as well as the benefits of using fertilizer and other inputs to raise yields and substitute for land. The next section investigates the policy significance of these biases, using recent data from Zimbabwe and Kenya.

The next section of the paper analyzes the source of bias in the DRC, and the rationale for preferring the SCB. The final section uses data from Zimbabwe and Kenya to illustrate the potential policy significance of the biased rankings. These data reveal the expected tendency of the DRC to exaggerate the benefits of activities using purchased inputs intensively, and to discriminate against factor-intensive low-input systems.

THEORETICAL PROPERTIES OF ALTERNATIVE INDICATORS

Indicators of economic efficiency are used primarily when the elasticities and other parameters of supply and demand functions are not known, and cannot be estimated in the available time. Nonetheless, indicators of efficiency can be constructed using average cost budgets, in which inputs and outputs are valued at shadow prices. Indicators typically use fixed input-output coefficients (thereby ignoring input substitution effects) and estimate the shadow price of each budget item separately (thereby ignoring cross price effects). Such simplifications imply that the resulting estimates are valid only for relatively small changes in activity levels; better estimates for larger changes would require an economic model showing equilibrium adjustments in production and consumption.

Definitions of the DRC and SCB

Budget data are normally presented in the form of revenues (R) and costs (C); because they are initially measured in different currencies, costs are often disaggregated into tradeable inputs (T) and non-tradeable domestic factors (D) such as labour and land. Also, because outputs are typically tradeable, tradeable costs (T) may be subtracted from revenue (R) to obtain tradeable value added (V).

Where no shadow exchange rate is available, Krueger (1966) and Bruno (1967) demonstrated that activities can be compared through the domestic currency cost of primary factors (D) used to generate a unit of foreign currency (V):

$$(1)\quad DRC = D/(R - T) = D/V$$

The units of such a 'relative' DRC are domestic currency per unit of foreign currency; this sort of measure can be used to rank alternative activities, but the cut-off between profitable and unprofitable activities is the unknown shadow exchange rate.

Warr (1983) demonstrated that the rankings produced with such a DRC may be incorrect unless a shadow exchange rate (e^*) is used to convert all values into a common currency, and all costs subtracted from all benefits to form a Net Present Value (*NPV*) or Net Social Benefit (*NSB*) measure. But the *NSB* measure would have specific units (for example, dollars per ha or per tonne of product), and therefore tends to favour more input-intensive, higher cost/higher benefit activities, even if a larger number of smaller activities would be more profitable. For activities that can be replicated at roughly constant returns to scale, like most farming enterprizes, a unit-free cost–benefit ratio is preferable.

Among cost–benefit ratios, using the shadow exchange rate in the *DRC* formula does not affect rankings; it merely re-scales the measure to allow the use of the *DRC* as a yes-no criterion, as all activities whose *DRC* is below one are socially profitable. The resulting 'absolute' *DRC* is:

$$(1') \quad DRC = D/e^*(R-T) = D/e^*V$$

In this paper the term '*DRC*' is used to refer to the absolute version of the *DRC*, since it is now far more commonly used than the relative one. The objective is to show that once all costs are converted into the same currency, the separation of domestic factor costs from tradeable inputs is no longer justified, and it is preferable to use a general social cost–benefit ratio (*SCB*):

$$(2) \quad SCB = (D + e^*T)e^*R$$

The *SCB* and the *DRC* are very similar measures. They use identical data, so there is no difference in terms of ease of calculation. Both are unit free ratios, unaffected by the scale of the activity and therefore preferable to measures such as net present value or net social profits which are denominated in scale specific units. But when choosing between the DRC and SCB, there are two fundamental reasons why the SCB is generally more accurate; one is well known, but to our knowledge the other has not been noted previously.

The first possible source of error in the *DRC* was highlighted by Bruno (1967), who noted that because the *DRC* requires separation of tradeable inputs (*T*) from domestic factors (*D*), it is subject to classification errors. If a tradeable input is mis-classified as non-tradeable, the *DRC* will be overstated, and vice versa. The *SCB* uses a shadow exchange rate to aggregate tradeable and non-tradeable costs and thereby avoid such errors, thus producing more accurate rankings[1].

The second source of error arises even if all costs and benefits are correctly measured and correctly classified. In this case, the two indicators are equivalent criteria for distinguishing efficient from inefficient activities: both the *DRC* and *SCB* will be greater than one for efficient activities, and less than one for inefficient ones. But the *DRC* and *SCB* can still rank activities differently, so the choice of indicator can have an influence on policy makers' priorities wherever all socially desirable activities cannot simultaneously be expanded.

Activity Rankings Under the DRC and the SCB

The *DRC* measures domestic factor costs per unit of tradeable value added. Choosing activities with the lowest *DRC* will produce the highest return to the domestic factors in terms of value added. But this is a true measure of national income or welfare only if domestic factors are fixed in supply. In fact, land and labour can move between activities, so that the supply of domestic factors to individual farm activities is not fixed — even though aggregate supply may be limited. At the margin, the opportunity cost of supplying domestic factors is captured by their shadow prices. Thus, as long as the best available estimate of these opportunity costs is used, the best available measure of the economic gains (or losses) from expanding a particular cropping activity is the returns to all inputs, both non-tradeable and tradeable. This is captured by the ratio of total social costs to total social benefits: the *SCB* rather than the *DRC*.

The possibility that the SCB will produce a different ranking than the *DRC* can be seen in Figure 1. To display the input mix in two dimensions we have normalized all activities to a common level of revenue ($\breve{R}$). These activities are mapped in terms of their domestic resource costs (*D*) along the vertical axis and tradeable input costs (*T*) along the horizontal axis, evaluated in a common currency. Along the diagonal 'break-even' line going from upper left to lower right costs exactly equal revenues so that the *DRC* and *SCB* ratios equal one. This line intersects the axes at the normalized level of revenues, $\breve{R}$. All activities that fall above the breakeven line have total costs greater than $\breve{R}$, and *DRCs* and *SCBs* greater than one, so the two measures are equally able to distinguish efficient from inefficient activities. Errors arise only in ranking activities with different input combinations: when, for example, comparing activity A with more factor-intensive activities that lie above and to the left of it, or more input-intensive activities that lie below and to the right. The *DRC* and *SCB* levels for A are different from one another; they are defined by:

(3) $DRC_A = D_A /(\breve{R} - T_A)$, and

(4) $SCB_A = (D_A + T_A)/\breve{R}$

Since revenues are fixed at $\breve{R}$, we can rearrange terms to find the sets of all activities sharing DRC_A and SCB_A. These sets are defined by the following equations:

(5) $D_A = DRC_A \cdot \breve{R} - DRC_A \cdot T_A$, and

(6) $D_A = SCB_A \cdot \breve{R} - T_A$

Thus a line through point A with the slope of minus DRC_A traces the set of all activities having DRC_A; a line through point A with a slope of minus one traces the set of all activities with SCB_A since these sets intersect only at A, conflicting rankings are possible. Algebraically, one set of activities for which *DRC* and *SCB* rankings conflict is the set of all X such that:

(7) $D_X/(\breve{R} - T_X) < D_A /(R_X - T_A)$ and $(D_X + T_X)/\breve{R} > (D_A + T_A)/\breve{R}$

Such activities would be ranked as more efficient than A using the *DRC*, but the *SCB* shows them to be less efficient. An example is activity B, in the shaded area below point A; relative to A such activities use tradeable inputs intensively.

Similar ranking conflicts arise for the set of all X such that:

(8) $D_X / (\breve{R} - T_X) > D_A / (\breve{R} - T_A)$ and $(D_X + T_X) / \breve{R} < (D_A + T_A) / \breve{R}$

These activities are judged to be less efficient than A using the *DRC*, but the *SCB* shows them to be more efficient. An example is activity C, in the shaded area above A; such activities are factor-intensive relative to A.

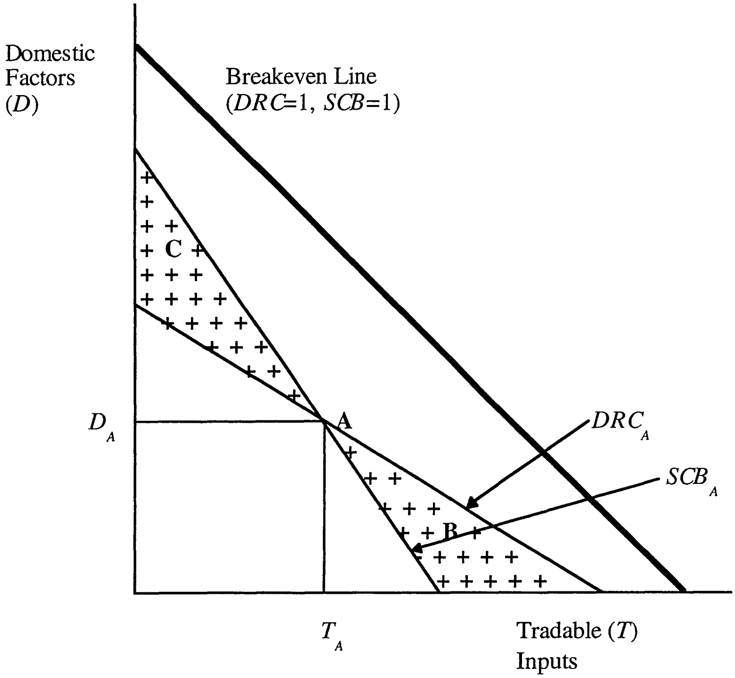

Figure 1 *Potential Ranking Conflicts Between DRCs and SCBs*

If policy makers are to choose among more than one socially desirable activity, the possibility of conflicting rankings makes it necessary to choose one ranking method over the other. In this context *SCB* rankings are more accurate than *DRC* rankings because transfering a given level of costs from tradeable and to non-tradeable inputs does not change total costs or total revenue and hence cannot affect welfare or economic growth. The marginal rate of substitution between tradeable and non-tradeable inputs is captured by the shadow exchange rate; as long as the rate used is the best available estimate, the *SCB* is the best estimate of economic efficiency, and the SCB_A line traces a true social 'indifference curve' among alternative activities.

For a given set of budget data and estimated economic opportunity costs, the *DRC* exaggerates the cost of domestic factors such as land and labour, as opposed to tradeable inputs. This leads the *DRC* to discriminate against factor-intensive activities, which is particularly important in developing countries where use of the *DRC* consistently understates the contribution of traditional smallholder farming systems relative to more 'modern' input-intensive production. The *DRC* exaggerates the benefits of using herbicides and mechanical equipment to substitute for labour, as well as the benefits of using fertilizer and other inputs to raise yields and substitute for land. In the next section we investigate the policy significance of these biases, using recent data from Zimbabwe and Kenya.

POLICY SIGNIFICANCE OF BIASES IN THE DRC INDICATOR

Data for Zimbabwe are taken from an analysis of the economic efficiency of nine crops across the country's three major farming systems: smallholder farms in low potential areas, smallholders in high potential areas, and large-scale commercial farms in high potential areas (Masters, 1994). For all crops, the smallholder systems use few purchased inputs, rely heavily on family labour, and generate low yields, whereas large-scale commercial farms use fertilizers, crop chemicals and machinery to achieve higher yields and reduce labour requirements.

Table 1 *DRC and SCB Indicators for Zimbabwe, 1989 Harvest Year*

Cropping activity		*SCB*		*DRC*	
System	Crop	Value	Rank	Value	Rank
Small scale	Maize	0.59	4	0.52	4
Low potential	Groundnuts	0.57	3	0.52	5
	Sunflower	0.99	11	0.99	11
	Pearl millet	2.79	16	4.34	16
	Sorghum	2.29	15	2.63	15
	Finger millet	1.18	14	1.20	14
	Whole farm	**0.73**		**0.68**	
Small scale	Maize	0.62	6	0.53	6
High potential	Groundnuts	0.91	10	0.89	10
	Sunflower	1.05	12	1.06	12
	Finger millet	1.17	13	1.19	13
	Cotton	0.77	9	0.72	9
	Whole farm	**0.67**		**0.60**	
Large scale	Maize	0.75	8	0.63	7
High potential	Groundnuts	0.53	1	0.42	1
	Cotton	0.56	2	0.43	2
	Wheat	0.74	7	0.65	8
	Soybeans	0.61	5	0.48	3
	Whole farm	**0.67**		**0.54**	

Table 1 shows the *DRC* and *SCB* values for each crop and each production technology, along with the relative ranking of each activity. Both measures agree that all three farm types are economically efficient on a whole-farm basis, and that only a few individual crops are not. But the rankings among crops differ. Since there is generally an elastic

Table 2 *DRC and SCB Indicators for Kenya, 1989–1990 Crop Year*

	Social Cost–Benefit Ratio (SCB)			Domestic Resource Cost Ratio (DRC)		
Rank	Class[a]	Crop[b]	Value	Class	Crop	Value
1	h	French Beans (KAK)	0.20	h	Oranges (NKU)	0.10
2	h	Irrigated Tomato (NYE)	0.20	c	Large-scale wheat (NKU)	0.12
3	h	Oranges (NKU)	0.22	h	Irrigated tomato (NYE)	0.12
4	h	Canning Tomato (NKU)	0.23	h	French Beans (KAK)	0.14
5	c	Maize-beans (KIS)	0.24	h	Canning tomato (NKU)	0.15
6	h	High Tomato (NKU)	0.31	c	Maize-beans (KIS)	0.19
7	te	Coffee (KIS)	0.33	c	Wheat (NKU)	0.19
8	te	Cotton (SIA)	0.35	h	High tomato (NKU)	0.21
9	c	Wheat (NYE)	0.37	c	Wheat (NYE)	0.25
10	c	Maize-beans (SIA)	0.40	h	Irrigated cabbage (NYE)	0.25
11	c	Maize-beans (KAK)	0.40	h	Potato (NYE)	0.29
12	te	Pyrethrum (KIS)	0.41	c	Maize-beans (NKU)	0.32
13	c	Maize (NYE)	0.41	te	Coffee (KIS)	0.33
14	c	Maize-beans (NKU)	0.41	te	Cotton (-SIA)	0.33
15	te	High pyrethrum (NKU)	0.42	c	Maize-beans (KAK)	0.34
16	h	Irrigated cabbage (NYE)	0.43	c	Maize (NYE)	0.34
17	c	Tractor maize (NKU)	0.43	c	Tractor maize (NKU)	0.35
18	te	Tea (NYE)	0.43	c	Maize-beans (SIA)	0.36
19	c	Lg.-scale wheat (NKU)	0.45	te	Tea (NYE)	0.37
20	h	Tomato (NYE)	0.47	c	Maize-beans (NYE)	0.38
21	c	Maize-beans (NYE)	0.47	h	Tomato (NYE)	0.39
22	h	Potato (NYE)	0.49	te	Pyrethrum (KIS)	0.40
23	te	Pyrethrum (NKU)	0.52	h	Potato (NYE)	0.40
24	c	Wheat (NKU)	0.54	te	High pyrethrum (NKU	0.42
25	c	Ox-plough maize (NKU)	0.58	h	Tomatoes (NKU)	0.44
26	h	Tomato (NKU)	0.60	te	Pyrethrum (NKU)	0.52
27	c	Improved sorghum (SIA)	0.62	c	Ox-plough maize (NKU)	0.53
28	h	Potato (NKU)	0.62	h	potatoes (NKU)	0.56
29	h	Irrigated potato (NYE)	0.64	te	Lg.-scale coffee (NKU)	0.59
30	te	Tea (KAK)	0.82	c	Improved sorghum (SIA)	0.59
31	te	Lg.-scale coffee (NKU)	0.82	te	Tea (KAK)	0.78
32	te	Coffee (NKU)	0.92	te	Coffee (NKU)	0.77
33	te	Coffee (NYE)	1.03	te	Coffee (NYE)	1.05
34	c	Finger millet (KIS)	1.13	c	Finger millet (KIS)	1.13
35	c	Local sorghum (SIA)	1.40	c	Local sorghum (SIA)	1.45
36	te	Tea (KIS)	1.94	te	Tea (KIS)	3.96

Notes: [a] Crop classifications are: h(horticultural), te (traditional export), c (cereal). [b] Crop locations are: KAK (Kakamega), KIS (Kisii), NKU (Nakuru), NYE (Nyeri), SIA (Siaya).

Source: Calculated from data in Pearson and Monke, 1995.

supply of factors to the individual crops (although not to agriculture as a whole), and since the shadow exchange rate was carefully estimated, the *SCB* ranking is to be preferred.

Using *DRC*s, the large scale system appears to be more efficient (*DRC* = 0.54) than either of the smallholder systems (*DRC* = 0.60 on high potential land, and *DRC* = 0.68 on low potential land). But the *SCB* measure shows the large- and small-scale production systems in high potential areas to have almost identical efficiency levels (*SCB* = 0.67), while production in low potential areas is less efficient (*SCB* = 0.73). In this study the shadow exchange rate was carefully estimated, so the *SCB* is preferable. And since identical data are used for all measures, the greater accuracy of the *SCB* is due entirely to its functional form.

Among individual cropping activities, the *DRC* makes three ranking errors among the sixteen activities shown; the most important of these may be that the *DRC* wrongly ranks large scale commercial soyabeans above groundnuts from smallholders in low potential areas. These two crops are close substitutes in the edible oils industry, so the difference in ranking could affect such policy decisions as the location of processing facilities or the investment in crop research.

Data for Kenya come from a study of agricultural systems in five districts reported in Pearson and Monke (1995). All farms are located in areas of high agricultural potential. Thirty-six cropping systems were drawn from three broad classes of crops: 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 purchased intermediate inputs (41 percent of total costs, as opposed to 24 percent for cereals and 16 percent for traditional exports). Although some of these crops can be produced only in specific locations (for example, pyrethrum, which is profitable only at high altitudes), as in Zimbabwe there is generally an elastic supply of land and labour for expanding production of each crop. And again, the best available estimate of the shadow exchange rate has been used, so the *SCB* is the preferred measure.

Table 2 compares the *DRC* and *SCB* measures calculated from the Pearson–Monke data. Clearly, the *DRC* favours the input-intensive mechanized wheat and horticultural crops, relative to more labour-intensive maize and traditional export crops. The *DRC* approach incorrectly ranks two of the mechanized wheat systems highly (second and seventh), while the *SCB* correctly ranks them lower (nineteenth and twentyfourth). Horticultural crops using substantial intermediate inputs are also ranked too high using the *DRC*, while traditional export crops which require more labour are ranked too low. None of the traditional export crops are in the top twelve under the *DRC*, but the *SCB* puts three in the top dozen (coffee, cotton and pyrethrum) and also raises the ranking of the major maize systems.

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 social profitability of horticultural crops and understates the contribution of maize and traditional export crops. These biases create the false impression that cereals and traditional exports contribute little to economic growth. In contrast, the *SCB* recognizes the value of these crops, and gives policy makers a more accurate picture of their social profitability relative to the new horticultural crops.

CONCLUSIONS

The appropriate use of indicators for ranking alternative activities is a long-standing theme of the project appraisal literature (for example, Gittinger 1982, pp.329–352). But policy analysts use them in slightly different circumstances, and ranking issues under these conditions have not been properly resolved in the literature. This paper has shown that in typical agricultural settings rankings based on domestic resource cost (*DRC*) ratios are biased against activities using domestic resources intensively. The use of the *DRC* is justified when the shadow exchange rate cannot be estimated, but where the best available shadow exchange rate is used, a social cost–benefit (*SCB*) ratio provides more accurate rankings of the social profitability of alternative activities. Evidence from Zimbabwe and Kenya shows the importance of using the more accurate indicator in policy analysis, particularly when comparing activities that have very different input combinations.

NOTE

[1] A similar source of error in the *SCB* arises from the need to separate costs and benefits: classifying costs as negative benefits could alter the ratio. For example, on-farm consumption of farm products could be put in any one of three budget categories: (a) a cost of production (hence added to the numerator), (b) a reduction in output (hence subtracted from the denominator), or (c) simply one of many sources of demand (which would not enter the measure at all). But this type of error affects the *DRC* as well, and is not a source of difference between the two measures.

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DISCUSSION OPENING — Brent Swallow *(International Livestock Centre for Africa, Nairobi)*

In their paper, Masters and Winter-Nelson show that domestic resource cost is a biased measure of the economic efficiency of alternative activities. Instead of *DRC*, analysts should use a broader measure such as benefit-cost ratio. I agree with most of their analysis and conclusions. In fact, I think that the have been relatively generous to many of the studies that have used *DRC* as a major measure of economic efficiency.

I relied heavily on Price Gittinger's (1982) 'Economic Analysis of Agricultural Projects' while preparing my comments. Gittinger discusses the advantages and disadvantages of several measures of project worth: net present worth, internal rate of return, benefit–cost ratio, net benefit-investment ratio and domestic resource cost. I looked particularly for what gittinger said about the usefulness of these measures for ranking alternative projects. Net present worth is an absolute, rather than a relative, measure of project performance. Benefit–cost ratio discriminates against projects with relatively high gross returns and operating costs, even though they may have a greater wealth-generating capacity than other projects with higher benefit–cost ratios.

Internal rate of return (IRR) can be used to rank projects by the criterion of contribution to national income relative to the amount of resources used. But the criterion that Gittinger recommends most highly for ranking projects is the net benefit–investment ratio (N/K). N/K is calculated as the present worth of the net benefits divided by the present worth of the investment. The N/K ratio can be used to select projects on the basis of returns to investments made during the initial phase of the project.

A limitation of both IR and N/K is that they cannot be calculated for projects that don't have at least one year with negative net returns.

A criterion that has a very special use is domestic resource cost (*DRC*). Masters and Winter-Nelson discuss the justification for the use of *DRC* and show how it is calculated. They criticize its use when one has a good estimate of the shadow value of foreign exchange. They show that the domestic resource cost indicator is biased against activities using domestic resources intensively. This is quite obvious: the measure does not consider the costs of tradeable inputs, ceteris paribus, the higher the proportion of tradeable to non-tradeable inputs, the better the project looks according to the *DRC* criterion.

I would submit that another obvious problem with the *DRC* is that it completely discounts activities that generate non-tradeable benefits. Activities producing sorghum and millet can therefore not be ranked by the *DRC* criterion. I think that Masters and Winter-Nelson committed a bit of an error when they calculated *DRC*s for pearl millet, sorghum and finger millet in their analysis of the Zimbabwe and Kenya data. A few days ago, Chris Gerrard presented a paper at this conference in which he argued that even maize should be regarded as a non-tradeable in southern Africa because of the large disparities between import-parity and export parity prices.

So the next questions are, how prevalent is the use of this biased measure of project worth? An answer to that question can be found by a scan of the Proceedings of the Eastern and Southern African Session at this conference. Three of the papers used *DRC* to compare projects and policies. None of the three used the net benefit–investment criteria, nor the internal rate of return, nor the benefit–cost ratio. In most of the studies it is unclear, but perhaps the analysts weren't able to calculate internal rate of return or net benefit–investment ratio because all of the projects were very short term so that farmers incurred all costs and received all benefits during the same year.

So why didn't those analysts use the benefit–cost ratio? None of them mentioned any problems in calculating the shadow value of foreign exchange and none of them discussed any special policies related to import substitution or export promotion. All of them used the Policy Analysis Matrix as their analytical framework. My only guess, therefore, is that analysts applied the PAM in a mechanistic way and didn't consider the strengths and weaknesses of the different decision criteria that it generates.

Therefore, I wish to thank Masters and Winter-Nelson for the useful contribution. I hope that it causes economists to go back to consider some of the basics of welfare theory and benefit–cost analysis when they analyze their data and report and discuss their results.