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Inequality, Resource Depletion, and Welfare Accounting: Applications to Indonesia and Costa Rica

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Summary. — Ahluwalia and Chenery noted that the standard measures of GDP growth imply distributional weights that place greater weight on the income of richer income groups, and proposed distribution-neutral and pro-poor alternatives. More recently, pilot studies by the World Resources Institute (WRI) have questioned the sustainability of GDP growth and have introduced natural resource modifications to national income accounting. To date, no studies have undertaken both revisions concurrently, creating a revised measure based on GDP but corrected for both distributional bias and resource depletion. Such a measure is derived in this paper, and its impact illustrated with data from Indonesia and Costa Rica, the countries studied by the WRI. © 1999 Elsevier Science Ltd. All rights reserved.

1. INTRODUCTION

Limitations of GDP per capita as an index of human welfare are too well known to warrant repetition. Alternative welfare indicators have existed for some time. The physical quality-of-life index (PQLI) and the human development index (HDI) emerged because of the belief that social factors not directly tied to income—e.g., literacy, life expectancy—were more fundamental to human welfare than per capita GDP.[1] Though not as widely reported as GDP, the HDI in particular is gaining worldwide recognition, as is the United Nations' annual rank-ordering of all the world's countries according to this indicator. Another alternative indicator, introduced by Ahluwalia and Chenery (1974), hereafter A&C) measures social welfare improvement with GDP growth as a starting point. A&C's approach involves recalculating country-level growth by placing greater weight on the income increases of the poorer income groups.

Interest has shifted somewhat in recent years, from whether GDP growth is conducive to welfare improvement, to whether such growth is environmentally sustainable. That is, the welfare of future generations seems to have supplanted that of the present as a dominant focus. The index of sustainable economic welfare (ISEW) is indicative of this change. As its name indicates, the ISEW adjusts individual consumption for environmental damage (among many other social costs) as a means of assessing whether the welfare generated for an economy is sustainable.[2] The ISEW offers the advantage that, unlike the PQLI and HDI, it is expressed in units of currency, so that it is directly comparable to GDP.

A related approach is the environmental income accounting first seen in a World Resources Institute (WRI) study on Indonesia (Repetto *et al.*, 1989) and followed by another WRI investigation on Costa Rica (Solórzano *et al.*, 1991). Rather than account for factors affecting welfare that GDP disregards, the WRI reports adopt a critical stance toward GDP's categorization as income of natural resource consumption. Each study revises conventional GDP in the respective country to account for the estimated value of natural resource depletion. Both reports, to be discussed at greater length, yield results which indicate that economic growth may eventually become unsustainable. In other words, the welfare of future generations in Indonesia and Costa Rica may have been compromised by excessive resource depletion.

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The main theme of this paper is that, to be complete, a social welfare indicator must reflect the well-being of both present and future generations.[3] The HDI and PQLI are lacking in that they only account for the well-being of the present generation, while the sustainability theme in the WRI studies reveals the authors' exclusive concern with future generations. The ISEW, in contrast, is appealing in that it incorporates variables relating to both present and future well-being. Another approach sensitive to both present and future generations would be to combine the WRI approach with A&C's distribution adjustments. To date, this has not been attempted. Moreover, the data requirements for the latter approach are far less onerous than for the ISEW[4]—especially for Indonesia and Costa Rica, countries for which the resource depletion accounts have already been calculated by the WRI. The present study thus develops an indicator which combines the WRI and A&C approaches, and applies it to these two countries.

The next section discusses the relationship between distribution and welfare, with particular attention to the A&C distribution weights model. Section 3 reviews the WRI method of natural resource accounting and its integration with national income accounts, as well as the results of the country studies. The A&C and WRI methods are combined in a new model developed in section 4, and the results of its application to the Indonesian and Costa Rican studies are presented in section 5. The final section offers some concluding remarks.

2. WELFARE ASSESSMENT: A DISTRIBUTION-WEIGHTED APPROACH

In considering what constitutes broad-based welfare improvement, it is helpful to consider two distinct problems. The first, and more fundamental, problem is what Sen (1981) terms *identification*: establishing an appropriate measure of well-being at the individual level. Does growth in an individual's real income necessarily result in a state of enhanced well-being, or can we envisage scenarios in which well-being might nevertheless decline due, for example, to deterioration in access to health or educational services? If well-being has nonincome components, how much relative importance do we accord to each variable? The second problem is *aggregation*: deriving a country-level indicator from individual-level performances. In other words, how much relative weight does one place on changes in the well-being of particular groups or individuals?

The HDI 'identifies' welfare as a function of longevity (i.e., life expectancy), education (literacy and amount of schooling) and standard of living (per capita income). The extent of distributional inequality can be assessed by computing the difference between a country's per capita income rank and its HDI rank.[5] Certain aspects of inequality can also be incorporated directly into the HDI. For example, the United Nations Development Programme (UNDP) has calculated revised HDIs which account for income or gender inequality (see, e.g., UNDP, 1995). Hicks (1997) takes this idea a step further, adjusting HDI not only for income inequality, but for inequality in literacy rates and life expectancy.

If there is a drawback to any of the above approaches, it is that they are not directly comparable to GDP, since the latter is denominated in currency units. In order to achieve symmetry in this regard, I accept the premise that per capita income and welfare are equivalent, despite obvious limitations with such an assertion. Identifying welfare improvement as growth in per capita income need not imply, however, disregard for inequality considerations, for the aggregation question—i.e., the issue of how much importance to place on the well-being of particular individuals or groups—remains unaddressed.

Atkinson (1970), Sen (1979, 1987), and others, for instance, believe it is feasible to assume that a marginal dollar generates greater welfare improvement if given to a poor person than if given to someone who is wealthy. The poverty indicator recently introduced by the UNDP similarly reflects the judgment that failure to improve the welfare of the poor cannot be 'washed away' by advances made by the wealthy, however large they may be.[6] Indeed, even the original HDI acknowledges the relative importance of the welfare of the poor: the index's standard of living component places far greater weight on national income below the world average than on that above it.

The above observations are implicit in an alternative measure of social welfare improvement developed by A&C, which also 'identifies' welfare as income. In addition to its disregard for social variables such as longevity and literacy, A&C's approach, unlike those mentioned earlier, only considers *growth* in the relevant variables. In general terms, A&C imagined that

a desirable objective of any country should be to increase social welfare, with welfare growth defined as follows:

$$W = \sum w_i g_i,$$

where W equals the rate of 'welfare growth,' i is the income group (quintile, for our purposes, with lower subscript representing wealthier quintile), g represents the income growth rate corresponding to group i, and w is the weight accorded to group i in the determination of W. A&C noted that GDP growth is a special case in which the weights on the income growth of each group are equal to the share of each group in total income. In other words, $w_j > w_{j+1}$, for all j. For example, if the highest income quintile garners 50% of national income while the lowest a mere 5%, the GDP growth measure gives 10 times more weight to the income growth of the wealthiest quintile than to that of the poorest.

A&C argue that giving equal social value to a given percentage change in the income of any individual, no matter from what income group, is a plausible alternative welfare measure. In other words, rather than employing 'GDP weights' in assessing social welfare, equal weights, as per the following formula, can be used:

$$W = \sum w_i g_i,$$

subject to $w_j = k$,

where k equals 1 divided by the number of income groups (i.e., $k = 0.2$ where quintiles are used). The objection can be raised that such a scheme employs interpersonal utility comparisons, a practice which, despite its intuitive appeal, is not acceptable in theoretical neoclassical welfare economics. The same objection, however, applies to the GDP weights method, or indeed, to any quantitative indicator of social welfare that aggregates individual characteristics.

Indeed, one can select whatever weighting scheme believed best in reflecting overall social welfare. For instance, we may prefer to base welfare almost exclusively on income growth of the poorest groups, placing little social value on upper-income growth beyond its contribution to social saving and investment.[7] Using these 'poverty weights' implies that there may be an upper limit to income, beyond which it no longer contributes to social development objectives. The poverty weights scheme would be as follows:

$$W = \sum w_i g_i,$$

subject to $w_j < w_{j+1}$ for all j.[8]

Since the question of which weighting scheme to employ is inescapably a normative exercise, the present study considers results according to all three alternatives. As noted earlier, however, adjustments to GDP growth for distributional disparity is only one of our concerns. The other, related to equity for future generations, is addressed in the next section.

3. HICKSIAN SUSTAINABLE INCOME AND THE WRI STUDIES

The WRI studies on Indonesia (Repetto *et al.*, 1989) and Costa Rica (Solórzano *et al.*, 1991) argue, from an accounting perspective, that GDP is invariably overstated because it includes depletion of natural resources (a form of capital consumption) as income. They conclude, therefore, that continuing to base economic policy on GDP growth threatens not only social welfare today, but also the long-run sustainability of national economies.

The theoretical basis for the WRI studies is a celebrated quotation by Hicks (1946), found in many recent studies on sustainable development:

> [I]ncome is the maximum value that a person can consume during a time period and still expect to be as well off at the end of the period as at the beginning (Hicks, 1946, p. 172).

This premise is, of course, easily generalized to the country level. Furthermore, though Hicks was not addressing natural resource issues, many economists today argue that Hicks' reasoning should apply to so-called natural capital as well as physical or man-made assets (e.g., Young and Serôa da Motta, 1995; El Serafy and Lutz, 1990).[9] If, and only if, after accounting for all capital consumption, income remains positive, the income is sustainable. It is sustainable because income in this instance would not imply a withering of a country's total asset stock. According to this perspective, sustainable income may be evidenced even if a country exhausts its natural resource base, as long as it invests sufficient proceeds from the depletion in its physical capital formation. If, alternatively, the country's ruling class uses most of the receipts to, for example, purchase mansions or deposit money in Swiss banks,

national income may not be sustainable (because Hicksian income would in all likelihood be negative).[10]

As mentioned earlier, Repetto *et al.* (1989) and Solórzano *et al.* (1991) adjust national income in Indonesia and Costa Rica for the estimated loss resulting from natural resource depletion, yielding a revised measure of GDP. Since the two reports give different names to the revised measure, we will, for purposes of the present study, call it depletion-adjusted domestic product (DADP).

In GDP terms, the Indonesian macroeconomy performed impressively during 1971–84, growing at an average annual rate of 7.1%. But, after adjusting for the lost value of petroleum, forestry, and soil, Repetto *et al.* show that DADP grew at a rate of only 4.0%. While additions to its petroleum stock bolstered Indonesia's DADP considerably in 1971 and 1974, the overall resource loss was substantial in the remainder of the years studied (see Table 1).[11] The cumulative loss during the period studied was nearly 20% greater than Indonesia's 1984 GDP!

While not as astounding as these numbers, the value of resource depletion in Costa Rica was nonetheless significant. Unlike in the case of Indonesia, Costa Rica's DADP growth rate was quite similar to its GDP growth rate (Table 2). But the cumulative loss resulting from depletion of the forestry, soil, and fishery accounts during 1970–89 amounted to 80% of the country's 1989 GDP.

If the WRI studies undertake to 'identify' welfare in a way that is biased toward the future (in that natural capital depletion figures prominently), they are silent on the aggregation question, in the sense that they do not make the equity adjustments proposed by A&C. The measure introduced in the next section, in contrast, addresses both concerns.

4. SYNTHESIS: RESOURCE DEPLETION WEIGHTS

The model presented here reflects the belief that income equality and economic sustainability are both welfare-relevant. Accordingly, the A&C weighting scheme is applied to Indonesia and Costa Rica's DADP (rather than GDP) to arrive at a new measure of resource depletion-adjusted welfare (RDAW). The weights employed are just as in A&C. In other words, for GDP weights, each individual growth rate is multiplied by the income share for the corresponding quintile. For equal weights, each rate is multiplied by 0.2. Finally, poverty weights are derived by extrapolating the weights suggested by A&C. The weights so obtained for the five quintiles are, respectively,

Table 1. *Comparison of GDP and Depletion-Adjusted Domestic Product (DADP) for Indonesia, 1971–84 (in billions of 1973 Rupiah)*

Year	GDP	Net loss in petroleum sector	Net loss in forestry sector	Net loss in soil sector	Net resource depreciation	DADP
1971	5545	−1527	312	89	−1126	6671
1972	6067	−337	354	83	100	6167
1973	6753	−407	591	95	279	7032
1974	7296	−3228	533	90	−2605	4691
1975	7631	787	249	85	1121	8752
1976	8156	187	423	74	684	8840
1977	8882	1225	405	81	1711	10,593
1978	9567	1117	401	89	1607	11,174
1979	10,165	1200	946	73	2219	12,384
1980	11,169	1633	965	65	2663	13,832
1981	12,055	1552	595	68	2215	14,270
1982	12,325	1158	551	55	1764	14,089
1983	12,842	1825	974	71	2870	15,712
1984	13,520	1765	493	76	2334	15,854
Total					15,836	
Avg. Annual Growth	7.1%					4.0%

Source: Repetto *et al.* (1989), p. 6.

Table 2. *Comparison of GDP and Depletion-Adjusted Domestic Product (DADP) for Costa Rica, 1970–89 (in millions of 1984 Colones)*

Year	GDP	Net loss in forestry sector	Net loss in soil sector	Net loss in fishing sector	Net resource depreciation	DADP
1970	93,446	3042	1940	0	4982	88,464
1971	94,382	4696	1875	6	6577	87,805
1972	100,912	3560	1986	7	5553	95,359
1973	116,525	4569	2082	5	6656	109,869
1974	122,740	4941	3180	−6	8115	114,625
1975	125,393	4614	2985	−16	7583	117,810
1976	132,310	3684	2531	−33	6182	126,128
1977	143,990	3823	2553	−65	6311	137,679
1978	153,124	3951	2350	−112	6189	146,935
1979	160,598	5921	2922	−93	8750	151,848
1980	161,894	5283	3088	−138	8233	153,661
1981	158,237	2673	2831	6	5510	152,727
1982	145,932	1938	3120	99	5157	140,775
1983	154,481	6669	2885	83	9637	144,844
1984	163,011	7517	3028	166	10,711	152,300
1985	169,299	7693	3265	273	11,231	158,068
1986	177,327	11,671	2497	386	14,554	162,773
1987	186,019	7665	2295	562	10,522	175,497
1988	207,816	17,890	2623	650	21,163	186,653
1989	231,289	18,028	2576	0	20,604	210,685
Total					184,220	
Avg. Annual Growth	4.9%					4.7%

Source: Solórzano *et al.* (1991), pp. 5, 7.

0.1, 0.133, 0.167, 0.25, and 0.35, starting with the richest quintile. Note that because of the greater weight placed on the income of the poorer quintiles, we should expect the annual RDAW growth rate for Indonesia under equal or poverty weights to exceed 4.0% if income distribution over 1971–84 improved, and to be lower if it has gotten worse. The same reasoning applies in the case of Costa Rica.

The problem with applying distribution weights to DADP is that, while A&C could base their calculations on available income distribution data, no such numbers exist for DADP. Hence assumptions are required. One possibility is simply to allocate DADP among the different quintiles according to their GDP income shares, and then aggregate using GDP, equal, and poverty weights. Doing so would imply that the share of the resource depletion burden (RDB) sustained by each income group is directly proportional to its income. This is precisely the weighting scheme implicit in the WRI studies, insofar as their revised measure of national income is taken as a measure of welfare. A serious shortcoming of these studies is their failure to address equity considerations, namely, how the resource depletion burden is distributed.

Often it is the poor who disproportionately absorb welfare losses resulting from natural resource depletion (Dasgupta, 1995; Martinez-Alier, 1995). For instance, clearing a forested area to set up a new cattle ranch might bring a net gain to the ranchers but most surely a loss to the people previously inhabiting the area. Or, the ecological consequences of resource depletion (e.g., landslides, soil erosion) might, at the margin, affect poorer individuals more than those more able to distance themselves from these problems. The wealthier groups, on the other hand, often suffer relatively little loss from resource depletion. A standing forest, for example, contributes relatively little to their well-being.

This possibility should therefore be considered in the present analysis. In what follows, I distinguish between 'cash' weights (w_i in the original A&C model) and 'RDB' weights, which apportion depletion losses across income quintiles. In the absence of hard data on the distribution of depletion losses, I consider three alternative weighting schemes. The first,

GDP RDB weights, imply that RDB is allocated according to income shares, as in the WRI reports. Equal RDB weights, in contrast, divide the total resource depletion into five equal parts, which are then subtracted from the aggregate income of each quintile. For example, the 2.3 trillion rupiah loss for Indonesia in 1984 is divided by five so each quintile is assigned a deduction of 460 billion rupiah *from their share of GDP*. This is in contrast to deducting 2.3 trillion from 13.5 trillion (1984 GDP) and *then* calculating the income shares, as done under GDP RDB weights. Finally, poverty RDB weights apportion a greater share of total resource depletion costs to the poor, using the same weights as under poverty cash-income weights. For example, 817 billion rupiah are deducted from the income share of the poorest quintile, while only 233 billion are taken from the share of the richest (see Appendix). Individual quintile growth rates under each of these three sets of RDB weights are then calculated and summed to arrive at alternative welfare growth rates, based on GDP, equal, and poverty cash weights, giving a matrix of nine alternative welfare measures in all.

Note that there is no inconsistency in combining, say, poverty RDB weights with equal or GDP cash weights. The two weighting schemes apply to entirely different aspects of the welfare problem. Cash weights refer to the aggregation problem: they define the relative importance to national welfare of income growth rates of the different quintiles. This is a normative issue, and all three scenarios are presented to demonstrate the effects of different normative stances. The RDB weights, in contrast, refer to the identification problem: they are used to adjust the extent to which 'cash' contributes to welfare for each quintile. This is a positive issue, and the three scenarios are presented here in the absence of adequate evidence to resolve it.

Finally, a few comments on the numbers employed. The figures for GDP and for the estimated monetary value of total resource loss are obtained from the WRI reports. Information on income distribution for the two countries comes from the World Bank (several years). Weights for both the cash and RDB adjustments are the same as used by A&C, except that the population is separated by income quintile throughout, consistent with the World Bank, but in contrast to the 20%, 40%, 40% disaggregation employed by A&C.

The limitations of income distribution data pertaining to less-developed countries (LDCs) should not be overlooked. For instance, the so-called income distribution data for Indonesia refer, in fact, not to the distribution of income but to the distribution of consumer expenditures. For that reason, the Indonesian distribution is less unequal than it would otherwise have been. In addition, for developing countries, comparisons of total income estimated from income distribution data (which are normally based on national surveys) and the total income from national accounts often indicate serious undercoverage in the survey data. These considerations imply that it is not always possible to obtain accurate weights for estimating adjusted GDP growth rates.

The statistics for the value of natural resource loss, culled from the WRI reports, must also be considered with caution. This is because natural resource loss (e.g., deforestation) is impossible to measure precisely, and simplifying assumptions (e.g., uniformity of mineral quality or timber) potentially misrepresent the values substantially. For instance, the assumption of uniform mineral quality in the WRI reports is misleading because decline of ore grade over time may significantly increase extraction cost, perhaps to the point where the mineral becomes economically worthless.

5. RESULTS

The annual DADP growth rates for Indonesia (4.0%) and Costa Rica (4.7%) serve as the starting point in the analysis (these growth rates reflect 'GDP weights' for both the cash and RDB dimensions). Notice first that income inequality diminished during the respective periods in both countries (Table 3). Because, as mentioned earlier, the equal and poverty cash weights place greater weight on the depletion-adjusted income growth of poorer income groups than the GDP cash weights, the improved income distribution in both countries implies more rapid growth in RDAW (as measured according to equal or poverty weights) than in DADP. The results bear this out. For Indonesia the respective numbers are 4.0, 5.0, and 5.5%, and for Costa Rica they are 4.7, 5.0, and 5.2% (Table 4).

As mentioned earlier, however, absent the RDB comparison, these numbers are based on the possibly unrealistic assumption that the loss resulting from natural resource depletion is

Table 3. *Change in income shares for Indonesia and Costa Rica (by income quintile)*

	Poorest quintile	Second quintile	Third quintile	Fourth quintile	Richest quintile	Ratio of highest to lowest
Indonesia (1971)[a]	6.6	7.8	12.6	23.6	49.4	7.5
Indonesia (1984)[b]	8.2	11.1	15.1	22.1	43.5	5.3
Costa Rica (1970)[c]	3.3	8.7	13.2	19.8	55.0	16.7
Costa Rica (1989)	4.0	9.1	14.3	21.9	50.7	12.7

Source: World Bank (various years).
[a] Approximation, as numbers were not available for 1971.
[b] Interpolated from readings for 1976 and 1987.
[c] Extrapolated from 1971 and 1989 data.

Table 4. *Annual growth in resource depletion-adjusted welfare (percentage per annum)*

		Cash weights		
		GDP	Equal	Poverty
(a) Indonesia, 1971–84				
	GDP	4.0	5.0	5.5
RDB Weights	Equal	4.0	3.4	2.8
	Poverty	3.9	2.0	0.0
		(Avg. annual GDP growth = 7.1%)		
(b) Costa Rica, 1970–89				
	GDP	4.7	5.0	5.2
RDB weights	Equal	4.7	4.8	4.8
	Poverty	4.6	4.3	3.9
		(Avg. annual GDP growth = 4.9%)		

Source: Author's calculations.

distributed according to the income shares. Therefore, individual quintile growth rates are calculated based on GDP, equal, and poverty RDB weights, and are each summed and weighted according to GDP, equal, and poverty cash weights, generating nine different growth rate calculations for each country. Table 4 summarizes these results.[12]

Our earlier observation that, due to improvements in income distribution, the RDAW growth rate increases as we move from GDP to poverty cash weights only holds when we assume GDP RDB weights (though RDAW growth remains more or less constant for Costa Rica when equal RDB weights are assumed). Why? Equal or poverty RDB weights result in a disproportionate reduction in the income levels of the poorer groups, since the same amount (or more, in the case of poverty weights) is subtracted from a much smaller annual income. Insofar as resource depletion increased in relative terms over the time periods studied (as was generally the case in both countries), this can signify considerably lower growth rates for the poorest quintiles (see Appendix). The explanation, then, for the numbers in Table 4 is that the welfare losses endured by the poor as a result of resource depletion eclipsed the gains they enjoyed as a result of improved income equality. This appeared to hold especially in the case of Indonesia.

In the extreme case where poverty weights are used for both cash and RDB, RDAW growth in Indonesia during 1971–84 is nonexistent. Even in the more moderate scenario of equal weights for both cash and RDB, the resulting growth rate of 3.4% is still less than half GDP growth. For Costa Rica, on the other hand, different scenarios do not alter the growth rate to nearly the same extent, even in the extreme poverty weights case. This is because the estimated value of resource depletion

in Indonesia was much greater (in proportion to GDP) than in Costa Rica. Because of this, the growth rates for the lowest quintiles were more sensitive to deductions for resource loss, and this was magnified in the case of poverty RDB weights, where the quintile growth rate for Indonesia was −7.1%.

The foregoing exercise is an illustration of the potential discrepancy between economic growth and an alternative welfare measure (RDAW). Though also based on income, RDAW, unlike GDP, accounts for changes in income inequality and distribution of RDB. The gap between these indicators can be considerable, especially using poverty weights for cash and RDB simultaneously, as evidenced in the case of Indonesia. Keep in mind that income distribution has improved in both countries! One can only imagine a case in which a country has suffered significant resource loss and *worsening* inequality. The discrepancy in the growth numbers under the alternative scenarios would undoubtedly be magnified, with negative RDAW growth (signifying a withering of national welfare) not unlikely.

6. CONCLUDING REMARKS

The model presented here was meant as an experiment, an opportunity to test a novel welfare indicator on two well-known country reports. This empirical application is useful in that, unlike most earlier reports, it addresses concerns over the welfare of both present and future generations. Moreover, the RDAW measure is more suitable for LDCs than the ISEW, given that its data requirements are not as demanding. Furthermore, given the massive resource depletion experienced by many LDCs, a measure such as RDAW, which stresses resource depletion, is more relevant to these countries.

The approach to welfare measurement adopted in this paper adjusts GDP only for income distribution, resource depletion, and the interaction between the two. I have not attempted further adjustments for nonincome, nonenvironmental aspects of welfare change, such as access to health care and education. As mentioned earlier in the paper, there have been important efforts in this direction in recent years, and the present work could be further extended by incorporating these dimensions in a broader welfare measure. Given the links among income distribution, environmental degradation, and other dimensions of human welfare, there can be little doubt that the measure of welfare improvement developed here represents a major improvement over GDP growth.

Further work on this subject would undoubtedly increase the accuracy and relevance of the RDAW indicator. I suggest three areas for future research. First, as mentioned, applying RDAW to an LDC that has become more unequal would better illustrate the possible contradiction between economic growth and enhancement of social welfare. Second, a sound basis for the RDB weighting scheme should be investigated. The poverty weights used in the present study, for example, were hypothetical. Can alternative weights, based on more precise estimates of RDB distribution, be envisioned? Finally, the model introduced in the present study, like those in earlier ones, is not a comprehensive welfare assessment. Only natural resources were considered. Environmental degradation as well as a host of other variables included in the ISEW were omitted. Of the natural resources, only the three most prominent were included. The estimated value of these resources was based exclusively on market price. Had the ecological and preservation benefits also formed part of the estimate, the resource depletion in Indonesia and Costa Rica would have surely been larger. Correcting for any or all of these limitations would most likely give us greater insight into the discrepancy between GDP and social welfare.

NOTES

1. The PQLI was introduced by Morris (1980) and the HDI can be found in the United Nations Development Programme's *Human Development Report*, first published in 1990 (see, e.g., UNDP, 1997). Of foremost concern to both indicators is progress in health (life expectancy, infant mortality) and education (literacy rates, mean years of schooling).

2. First seen in Daly and Cobb (1989) relating to the US economy, and since applied to the case of several European nations by other authors. See, e.g., Stockhammer *et al.* (1997).

3. Not that there is no overlap or cause-effect relationship between equity and sustainability. Indeed, Boyce

(1994), Martinez-Alier (1993, 1995), and Torras and Boyce (1998) argue that social equality helps mitigate environmental degradation. For purposes of the present study, however, equity and environmental issues are treated independently.

4. Presently, LDCs such as Indonesia and Costa Rica, the countries of interest here, lack the necessary resources to compile accurately the information required for an ISEW calculation. The ISEW adjusts downward for, among other things, long-term environmental damage, expenditures on advertizing, costs of commuting, car accidents, and noise pollution; and upward for services from household labor, consumer durables, streets and highways, and public expenditures on health and education, as well as other factors. See Daly and Cobb (1989).

5. That is, countries which rank significantly better in HDI—such as Costa Rica and Vietnam—have translated what economic growth they have experienced into improvements in the lives of their people. In contrast, countries with considerably higher per capita GDP ranks—Kuwait or Saudi Arabia, for example—have probably experienced relatively inequitable economic growth (see UNDP, 1997, p. 46).

6. UNDP (1997), p.15. The UNDP's human poverty index (HPI) only accounts for the progress of society's poorest members in achieving acceptable longevity, literacy, and living standards (the latter defined by the UNDP in terms of percentage of population with access to health services and safe water, and the percentage of children under age five who are malnourished).

7. Doing so would be akin to increasing Atkinson's inequality aversion parameter (ϵ), signifying greater concern for well-being of the lower end of the distribution. See Atkinson (1970), p. 257.

8. A&C use poverty weights of 0.1, 0.3, and 0.6 for the richest 20%, middle 40%, and poorest 40% of the population. One might, alternatively, use the inverse of the income shares. Such an approach in our earlier example would signify that w_1 would be equal to 1/.55, or 1.82, while w_5 would be 1/.05, or 20 (with $\sum w_i$ normalized to equal one).

9. Since it is tangential to the main theme here, I will not go into the rationale for giving natural resources equal status as physical assets in national income accounting. For detail on the subject, I refer the reader to the WRI studies, or to Ahmad, El Serafy and Lutz (1989).

10. The non-negative income criterion is in contrast to the more stringent conditions, not discussed here, required by two competing schools of thought. One of these groups is what Victor (1991) has called the London School (named after ecological economists at the London Centre for Environmental Economics). This group requires, in addition to non-negative income, a nondecreasing natural capital stock. This further requirement is on grounds of uncertainty over future consequences of continued depletion (so-called threshold effects), irreversibility, and a general belief that natural resources and physical capital are complements rather than substitutes. In contrast, the thermodynamics perspective finds continued economic growth wholly inconsistent with sustainable development because of the finite amount of low entropy resources (required for sustained growth) which are available. In other words, sustainable development, if possible, would require humans to progress beyond conceptions of well-being based on the narrow production-based criterion—basically because perpetual growth in production is an impossibility (see, e.g., Daly, 1991, or Georgescu-Roegen, 1971).

11. Both WRI studies utilized the "depreciation approach" to resource valuation, which essentially treats natural resources as fixed assets. Consequently, new discoveries of petroleum reserves are negative depreciation, if you will, or value added. This is in sharp contrast to the user cost approach advocated by El Serafy (see, e.g., El Serafy and Lutz, 1990) which views natural resources as inventories and thus treats new discoveries as a mere prolonging of the resource depletion time horizon (hence having a minimal impact on value added for the year in which the discovery is made).

12. See Appendix for detail on all calculations.

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APPENDIX

See Table A1 and calculations below.

Table A1. *Individual quintile growth rates*

(a) Indonesia

	DADP		Deduction, equal RDB weights		Deduction, poverty RDB weights		Individual quintile growth rates 1971–1984		
	1971	1984	1971	1984	1971	1984	GDP RDB weights (%)	Equal RDB weights (%)	Poverty RDB weights (%)
Poorest quintile	440	917	−225.2	466.8	−394.1	816.9	5.8	0.6	−7.1
Second quintile	520	1242	−225.2	466.8	−281.5	583.5	6.9	3.5	1.9
Third quintile	841	1689	−225.2	466.8	−187.7	389.0	5.5	4.2	4.9
Fourth quintile	1574	2472	−225.2	466.8	−150.1	311.2	3.5	3.9	4.8
Richest quintile	3295	4866	−225.2	466.8	−112.6	233.4	3.0	4.7	5.4
Total	6671	11,186	−1,126	2,334	−1126	2334	–	–	–

(b) Costa Rica

	DADP		Deduction, equal RDB weights		Deduction, poverty RDB weights		Individual quintile growth rates 1970–89		
	1970	1989	1970	1989	1970	1989	GDP RDB weights (%)	Equal RDB weights (%)	Poverty RDB weights (%)
Poorest quintile	2919	8419	996.4	4120.8	1743.7	7211.4	5.7	4.8	2.2
Second quintile	7696	19,153	996.4	4120.8	1245.5	5151.0	4.9	4.6	4.5
Third quintile	11,677	30,098	996.4	4120.8	830.3	3434.0	5.1	5.1	5.1
Fourth quintile	17,516	46,091	996.4	4120.8	664.3	2742.2	5.2	5.3	5.3
Richest quintile	48,655	106,921	996.4	4120.8	498.2	2060.4	4.2	4.4	4.4
Total	88,464	210,685	4982	20,604	4982	20,604	–	–	–

Resource distribution-adjusted welfare (RDAW) calculations (compare with figures in Table 4)

Indonesia

GDP RDB weights, GDP cash weights:
5.8 (.074) + 6.9 (.0945) + 5.5 (.1385) + 3.5 (.2285) + 3.0 (.4645) = 4.0

GDP RDB weights, equal cash weights:
5.8 (.2) + 6.9 (.2) + 5.5 (.2) + 3.5 (.2) + 3.0 (.2) = 5.0

GDP RDB weights, poverty cash weights:
5.8 (.35) + 6.9 (.25) + 5.5 (.167) + 3.5 (.133) + 3.0 (.1) = 5.5

Equal RDB weights, GDP cash weights:
0.6 (.074) + 3.5 (.0945) + 4.2 (.1385) + 3.9 (.2285) + 4.7 (.4645) = 4.0

Equal RDB weights, equal cash weights:
0.6 (.2) + 3.5 (.2) + 4.2 (.2) + 3.9 (.2) + 4.7 (.2) = 3.4

Equal RDB weights, poverty cash weights:
0.6 (.35) + 3.5 (.25) + 4.2 (.167) + 3.9 (.133) + 4.7 (.1) = 2.8

Poverty RDB weights, GDP cash weights:
-7.1 (.074) + 1.9 (.0945) + 4.9 (.1385) + 4.8 (.2285) + 5.4 (.4645) = 3.9

Poverty RDB weights, equal cash weights:
-7.1 (.2) + 1.9 (.2) + 4.9 (.2) + 4.8 (.2) + 5.4 (.2) = 2.0

Poverty RDB weights, poverty cash weights:
-7.1 (.35) + 1.9 (.25) + 4.9 (.167) + 4.8 (.133) + 5.4 (.1) = 0.0

Costa Rica

GDP RDB weights, GDP cash weights:
5.7 (.0365) + 4.9 (.089) + 5.1 (.1375) + 5.2 (.208) + 4.2 (.529) = 4.7

GDP RDB weights, equal cash weights:
5.7 (.2) + 4.9 (.2) + 5.1 (.2) + 5.2 (.2) + 4.2 (.2) = 5.0

GDP RDB weights, poverty cash weights:
5.7 (.35) + 4.9 (.25) + 5.1 (.167) + 5.2 (.133) + 4.2 (.1) = 5.2

Equal RDB weights, GDP cash weights:
4.8 (.0365) + 4.6 (.089) + 5.1 (.1375) + 5.3 (.208) + 4.4 (.529) = 4.7

Equal RDB weights, equal cash weights:
4.8 (.2) + 4.6 (.2) + 5.1 (.2) + 5.3 (.2) + 4.4 (.2) = 4.8

Equal RDB weights, poverty cash weights:
4.8 (.35) + 4.6 (.25) + 5.1 (.167) + 5.3 (.133) + 4.4 (.1) = 4.8

Poverty RDB weights, GDP cash weights:
2.2 (.0365) + 4.5 (.089) + 5.1 (.1375) + 5.3 (.208) + 4.4 (.529) = 4.6

Poverty RDB weights, equal cash weights:
2.2 (.2) + 4.5 (.2) + 5.1 (.2) + 5.3 (.2) + 4.4 (.2) = 4.3

Poverty RDB weights, poverty cash weights:
2.2 (.35) + 4.5 (.25) + 5.1 (.167) + 5.3 (.133) + 4.4 (.1) = 3.9