Environmental Damage and its Impacts on Inequality and Poverty: Applications to Brazil and Costa Rica

Mariano TorrasAdelphi University*

Accounting for environmental damage is relevant to how we measure the extent and severity of inequality and poverty, and the question of ecological distribution - how the costs associated with environmental damage are distributed across the population - is critical. Following Khan's (1997) study on Bangladesh, I use environmental damage estimates to adjust inequality and poverty measures for Brazil and Costa Rica. Unlike Khan, I test for different assumptions regarding the ecological distribution. Provisional results indicate that inequality and poverty are understated, and that, under certain assumptions, both worsened in Costa Rica during the 1980s, contrary to what conventional statistics suggest. Want of reliable ecological distribution data, however, suggests that sensitivity analysis around competing assumptions may be preferable to conventional indicators.

Keywords: Brazil, Costa Rica, inequality, poverty, environmental damage, resource depletion
JEL Classifications:

Introduction

Many recent studies reveal one or another of two principal weaknesses related to the analysis of economics and the natural environment. The first is an almost exclusive focus on the economic causes of environmental damage, with far less attention to its consequences.[1] Often ignored is the fact that at least some types of environmental damage diminish the ability of growth to combat severe income inequality or poverty. In such instances a negative feedback loop may follow, since as argued by Boyce (1994), environmental damage is likely to be greater in cases where society is more polarized in terms of wealth and power.

A second significant limitation is that where some research does attend to consequences of environmental damage, most emphasizes its effects on growth in income or Gross Domestic Product (GDP). The sustainable-development literature,

* *Address for correspondence*: Mariano Torras, Adelphi University, 1 South Avenue, Garden City, NY 11530. E-mail: torrasm@panther.adelphi.edu

for example, and ecological economics in particular, are concerned with such issues as the 'environmental sustainability' of GDP growth. Yet the extent of inequality and poverty are arguably as important as income per capita in assessing well-being, and far less consideration has heretofore been given to the effects of environmental damage on either of the problems. This study seeks to fill both gaps in the literature. In contrast to earlier studies that factor estimated environmental damage into a country's income accounts, I consider to what extent common measures of inequality and poverty are affected by such damage.

It is well known that GDP growth, poverty, and inequality are interrelated, and over the past 50 years the subject has received considerable attention, especially in the development-economics literature. Earlier studies generally find that while strong GDP growth with few exceptions improves a country's poverty picture, it does not always reduce income inequality (e.g., Fields, 1980; McKay, 1997). De Janvry and Sadoulet (2000) and Psacharopoulos et al. (1995) reach similar conclusions in studies confined to Latin America during the 1970s and 1980s. I select two countries from the latter group—Brazil and Costa Rica—to see if the conclusions are altered once we account for environmental damage. I choose the two because of their strikingly different experiences during the 1970s and 1980s, and also because both are well known to have severely damaged or depleted their environments over the past few decades.

The method, here employed, to adjust conventional inequality and poverty indexes follows from Khan's 1997 study on Bangladesh. Unlike his and other similar studies, however, I also account for what I will refer to as 'ecological distribution' (see, e.g., Beckenback, 1996), meaning inequality in the distribution of the social cost associated with environmental damage. I find that inequality and poverty in Brazil and Costa Rica were generally understated over the relevant periods and, more surprisingly, that inequality and poverty trends are completely reversed in Costa Rica, under certain specific ecological distribution assumptions. Yet the amount of distortion or misrepresentation in the conventional statistics depends crucially on available information about the ecological distribution. Absent adequate data on the matter, my results suggest a more important role for sensitivity analysis in measuring the links between environmental damage, poverty, and inequality.

Growth, inequality, and poverty: the Environmental nexus

Growing concern among economists over the state of the natural environment has added a new dimension to one of the fundamental problems in the field: the timeless controversy over whether economic policy should emphasize growth at the short-run expense of a just income distribution or vice-versa. This issue is further complicated when we try also to account for the natural environment. Environmental damage is widely believed to influence both growth and distributional equity. Some believe that damage beyond a certain threshold is inimical to both objectives.[2] Such damage may, moreover, diminish the ability of growth to combat absolute or relative deprivation in society.

Kakwani and Pernia (2000), for example, distinguish among growth outcomes according to the degree to which they are 'pro-poor'. Dasgupta and Mäler (1990), among others, describe a possible feedback effect in which growth that is *not* pro-poor—i.e., immiserizing—in turn further worsens environmental conditions. While such an effect might correspond well with received wisdom about the so-called poverty-environment trap, the link is not definitively established. In their study of Cambodia, Laos, and Viet Nam, for example, Dasgupta et al. (2005) find ambiguous support at best.[3]

The original relationship between growth, poverty, and inequality is already devilishly complex and has been researched to a considerable extent. Concerned with the manner in which GDP growth sometimes conceals worsening poverty, Ahluwalia and Chenery (1974) were among the first to employ an alternative accounting scheme that places greater weight on the income of poorer groups. Eastwood and Lipton (2000) argue that the ability of growth to reduce poverty depends in large part on the degree of existing income inequality, and Foster and Székely (2000) note how conclusions on the matter are sensitive to the manner in which well-being—especially well-being for the poor— is defined, concluding that growth in general *is* good for the poor, albeit not as good as for better-off individuals. In a similar vein, Ravaillon (1997) distinguishes between 'good' and 'bad' growth, the latter improving well-being for the poor only marginally if at all.

It is certainly conceivable that growth often causes all segments of the population to gain in absolute terms even if inequality is intensified. Yet, as repeatedly emphasized in the ecological-economics literature (Ayres, 1995; Costanza and Daly, 1992 and Ekins et al., 2003), growth also often produces deleterious environmental consequences. Studies abound that claim to develop or estimate values for any of an assortment of alternatives to the GDP, most if not all of which account for environmental damage (e.g., Serafy and Lutz, 1990; World Bank, 1994). Examples include the so-called green GDP, the Index of Sustainable Economic Welfare (ISEW), and the Genuine Progress Indicator (GPI). Nevertheless, and especially important to the present discussion, all of the above focus on national income or broader well-being rather than inequality or poverty *per se*.

How might the inequality and poverty picture change if we took into account the estimated monetary value of environmental damages? Khan (1997) makes just such an allowance in estimating adjusted measures of inequality and poverty for Bangladesh, concluding—based on specific assumptions to be discussed shortly—that both are considerably understated by the conventional (unadjusted) statistics. Khan justifies adjustments to the inequality and poverty statistics on grounds that environmental damage increases the defensive expenditures individuals face, such as increased health-care costs resulting from pollution-induced illness. In other words, despite receiving the same money income, such individuals experience a lower level of well-being than in the absence of the environmental damage.

Further support can be found in the work of Dasgupta and Mäler (1990), who note that for people in agrarian economies not far above subsistence, natural resources are often *complementary* to other goods and services, so that depletion of the natural-resource base creates destitution, even in the face of increasing prosperity at the aggregate (national) level. Reddy and Chakravarty (1999) conclude similarly, although in their case the results are unambiguous for poverty, but not for inequality. It is nevertheless probably not unreasonable, in light of the above considerations, to expect the inequality and poverty picture to be more stark than suggested by conventional statistics, especially when the country in question suffers substantial environmental damage.

Any attempt to revise inequality or poverty measures on the basis of environmental damage of course begs the question, of course, of how such damage is distributed across the population. It is a question of what Martinez-Alier (1995) terms *ecological distribution*, an important sub-category of the more general field of political ecology, for which there exists an entire separate literature. Unfortunately, the problem is one which, at least to date, is not lending itself to easy measurement or quantification; indeed, ecological change and its effects are more qualitative in nature. Integrating ecological distribution into the inequality and poverty adjustments requires therefore simplifying assumptions, to be discussed in the section that follows.

Methodology

Since the Gini coefficient is derived from the income shares of different percentile groups, it is not an exceedingly difficult matter to revise the coefficient so that it accounts for a given monetary assessment of environmental damage. Khan notes that, assuming an income-distribution vector α and an estimated environmental damage estimate of x monetary units per person, we can derive a new vector β by subtracting x from each of the individual incomes. For a given individual's earning α_i (i = 1, 2, 3......n), his 'real' income becomes $\beta_i = \alpha_i - x$. Gini indexes can be computed for the original vector $\alpha = (\alpha_1, \alpha_2, \alpha_3....\alpha_n)$ as well as for the 'environmentally adjusted' vector $\beta = (\beta_1, \beta_2, \beta_3....\beta_n)$. Even though according to the framework everyone is presumed to lose equal amounts in absolute terms, the poor lose more relative to their income. It therefore stands to reason that $G(\beta)$ should always exceed $G(\alpha)$, in other words, that accounting for environmental damage should result in income's being distributed more unequally than in the absence of the modification. As noted, Khan confirms this to be the case for Bangladesh.[4]

If we fail to account for environmental damage, poverty also is underestimated.

In terms of the headcount index (percentage of the population below the poverty line), it is clear that subtracting some amount x from everyone's income can only increase this percentage since everyone is made poorer. The same is true of the poverty-gap measure, which accounts for the severity as well as the incidence of poverty:

$$poverty\ gap = \frac{1}{n} \sum_{(i=1)}^{p} (G_i/Z) \tag{1}$$

where $n =$	total population
$p =$	number of poor
$z =$	poverty line
$G_i =$	income shortfall of ith individual.

The number of poor (p) increases for the reason given above and G_i increases, or at least remains the same, for all i, if we subtract some constant x from each individual's income. If p increases and G_i is non-decreasing for all i, the poverty gap must increase.

Khan examines the Foster, Greer, and Thorbeche (FGT) index that accounts for caloric – as opposed to income – deprivation.[5] Although The FGT differs slightly from the headcount and poverty-gap measures, but they are related and the conclusions to be drawn from the results of the environmental damage adjustments are essentially the same. For his own part, however, in addressing the matter of ecological distribution, Khan employs an 'Equality of Misfortune' Assumption (EMA) on *a fortiori* grounds. The assumption, on which I have thus far not yet elaborated, is that environmental damage is not distributed equally across the population (i.e., the claim is that everyone does not suffer the same damage, the'x' in our earlier example). In other words, Khan believes that the implications of his study would be strengthened if one were to adopt the less conservative assumption that the poor on average shoulder more of the environmental damage than the rich, not only relative to income, but in absolute terms (call it the 'Regressive Impacts' Assumption – or RIA for short).

Of course the assumptions that all groups suffer equally relative to income, or more generally that the rich suffer more environmental damage in absolute terms are also possible ones to entertain. In the specific case, the adjusted Gini coefficient would be identical to the conventional Gini (since relative income shares would be unaffected), while in the general case it is possible, under certain assumptions, that the Gini *w*ould overstate the degree of inequality. With the poverty measures, in contrast, any ecological distribution assumption would result in poverty being understated, since any across-the-board income reduction – even if overwhelmingly directed at the rich – would increase both the incidence and severity of poverty.[6]

The most suitable distribution scheme on which to base the proposed reassessment is likely to depend on what Beckenback (1996) refers to as the 'dimension' of ecological distribution in question. He distinguishes between single resources of more or less exclusive character (e.g., commodity resources) and system properties (e.g., interacting resources and elements composing entire ecosystems). Since revenue streams from the former are likely to accrue disproportionately to the rich, it is not unreasonable to assume for simplicity that ecological damage is suffered in proportion to income when accounting for a reduction in, say, marketable timber stock or petroleum reserves.[7]

Recent work in ecological economics and political ecology supports the opposing argument that the RIA will usually apply in the case of damage to whole ecosystems. Dasgupta (1995) and Martinez-Alier (1993), among others, claim that the poor generally suffer disproportionately in such cases, particularly in lesser-developed countries (LDCs).[8] Separate studies on Botswana (Arntzen, 1996), India (Reddy and Chakravarty, 1999), and Malawi (Fisher, 2004), also find that human-induced ecological changes disproportionately harm the poor. The latter two emphasize forest area as an important source of income for relatively asset-poor households, often helping keep families out of poverty. In his study on Brazil, Torras (2003) similarly finds a complementarity between natural resources and consumption goods.

In the analysis to follow, data from Brazil and Costa Rica will be considered for the period roughly spanning the 1970s and 1980s. Since most of the deforestation occurring in each country was motivated by pursuits other than timber exporting (e.g., farming, family resettlement, mining), the environmental damage does not result as much from foregone revenue streams as it might, say, in the case of large timber exporting countries like Indonesia or the Philippines. The 'damage-in-proportion-to-income' assumption is thus less likely to apply. In the comparison of adjusted to non-adjusted Gini and poverty indexes for Brazil and Costa Rica, the analysis is therefore limited to the two assumptions, the EMA and the RIA.[9]

In applying the RIA, the assumption of Torras (2003) is retained: environmental damage is suffered in inverse proportion to income shares. In other words, if the richest quintile in the population earns fifty per cent of national income and the poorest three per cent, it is assumed that the first group suffers three per cent of the environmental damage and the latter group one-half of it. Certainly there are no strong *a priori* grounds for such a specification, except, possibly, symmetry with the opposite case already discussed. Absent reliable data on ecological distribution, however, no precise method yet suggests itself, and it is left to the readers and researchers to examine the sensitivity of my conclusions to alternate measurement schemes.

Application to Brazil and Costa Rica

Brazil experienced strong albeit inconsistent growth from 1970 to 1989. GDP grew at 8.6 per cent per annum from 1970 to 1980, 2.4 per cent for 1980-89, and 5.6 per cent for the entire period. Even per capita income growth was robust, albeit only in the first sub-period, with the respective rates being 5.7 per cent, 0.5 per cent, and 3.2 per cent. Costa Rica's growth was slightly less rapid on average than Brazil's, although less inconsistent and considerably stronger during the 1980s. Divided into similar sub-periods, GDP growth was 5.6 per cent (2.8 per cent per capita) during the 1970s, 4.0 per cent (1.2 per cent per capita) during the 1980s, and 4.9 per cent (2.0 per cent per capita) for the entire 1970-89 period.

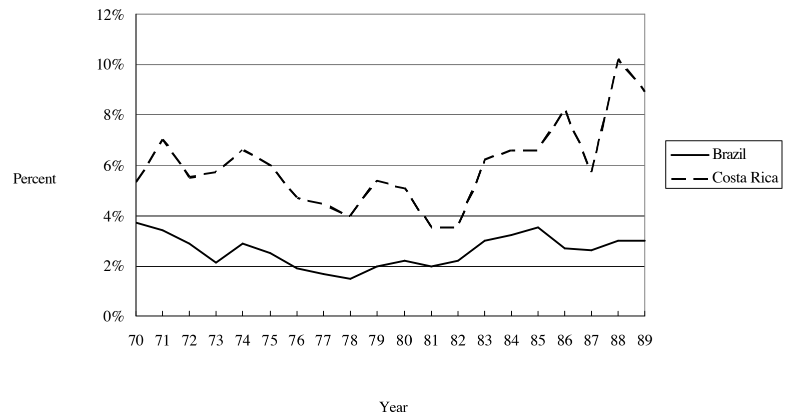
While, by most measures, poverty in Brazil declined over the past few decades, it appears that the opposite happened during the 1980s (McKay, 1997; Psacharopoulos et al., 1995). Income distribution in Brazil also clearly became more unequal during the 1980s, after its having improved somewhat during the 1970s. The phenomenon was in part due to the gradual isolation of the Northeast (already the poorest region in the country) from the rest of Brazil, since it led to worsening conditions for many individuals on the lower end of the income scale (Goldsmith and Wilson, 1991). For Costa Rica, there is a less ambiguous improvement in both the income-inequality and poverty pictures, although it is debatable how much of the improvement was growth-driven. Taylor-Dormond (1991) concludes that it was mostly due to government intervention favoring Costa Rican social programs, and Rodriguez and Smith (1994) highlight the role of education in reducing poverty, particularly in urban areas.

We now consider the extent to which the above findings are affected when we account for environmental damage. The hypothetical environmental damage scenarios constructed by Khan (1997) are not necessary in the present study because environmental damage estimates already exist for Brazil and Costa Rica. The relevant data are from natural-resource accounting studies on each by, respectively, Torras (2003) and Solyrzano et al. (1991). Both studies report estimated losses in their respective countries in the three dominant natural-resource sectors and adjust GDP accordingly.[10]

Figure 1 presents estimates of natural resource losses for Brazil and Costa Rica, as a percentage of GDP. The relative losses for both countries in most cases exceed the damage-GDP ratios considered by Khan in his Bangladesh study – 0.5, one, and two per cent – though, in fairness to the author, he did note in his study that his assumptions were 'fairly conservative'. Damages are higher in Costa Rica than in Brazil for every year spanning 1970 and 1989. The finding may surprise some, but the reader should keep in mind that the Brazilian GDP is 65-70 times greater than Costa Rica's, so environmental damage in Brazil is much greater in absolute terms.

Monetary estimates used here pertain exclusively to resource depletion. Even

Figure 1
Resource Depletion as a percentage of GDP



though, for consistency, we will continue to refer to these as the 'environmental damage' estimates, they do not account for lost or diminished ecological benefits such as climate regulation, nutrient cycling, etc. While Torras (2003) does, in a portion of his investigation, account for such benefits, these are not included here, for two reasons. First, such estimates are by their nature much more speculative than those associated with squandered economic benefits associated with marketable raw materials. Second, disregarding them here allows us to compare between outcomes for Brazil and Costa Rica, even if only in a limited sense.

Gini coefficients were obtained from Chen, Datt and Ravaillon (1995); Fields (1989); Psacharopoulos et al. (1992), and the World Bank (1989; 1996). Although data were available for more years, figures for only three years were used for each country, in each case spaced by approximately a decade. Data on poverty are unfortunately more scant, with the systematic collection of headcount and poverty-gap statistics for the world's countries only a recent phenomenon. I use the data in Psacharopoulos et al. (1995), who provide poverty statistics for Brazil and Costa Rica in 1980 and 1989. Owing to data insufficiency it is possible to consider only the decade of the 1980s for the poverty analysis.

All the sub-periods of reasonably strong GDP growth – Brazil in the 1970s and Costa Rica in both the 1970s and 1980s – produced reductions in income inequality. Perhaps not surprisingly, one sub-period of modest growth (in this case, Brazil in the 1980s, with a per-capita income growth of 0.5 per cent) results in an increased Gini value. Yet as expected, the conventional statistics understate the magnitude of the original problem. As shown below in Table 1, the Gini index is considerably higher for both countries after the estimated environmental damage is factored in. In the EMA case, the Gini increases are caused by the fact that the poor lose more than the rich in relative terms.

Yet without exception, the Gini coefficient is highest in the RIA case – that is, assuming that the poorest quintile bears the preponderance of the social cost associated with the damage.

Table 1a
Brazil: Income Inequality, Conventional and Adjusted

Year	Gini Coefficient	Change	Equality of Misfortune Adjustment	Change	Regressive Impact Adjustment	Change
1972	0.610	—	0.654	—	0.672	—
1979	0.594	-0.016	0.625	-0.029	0.637	-0.035
1989	0.634	0.040	0.672	0.047	0.690	0.053

Table 1b
Costa Rica: Income Inequality, Conventional and Adjusted

Year	Gini Coefficient	Change	Equality of Misfortune Adjustment	Change	Regressive Impact Adjustment	Change
1971	0.492	—	0.531	—	0.567	—
1981	0.475	-0.017	0.492	-0.039	0.509	-0.058
1989	0.461	-0.014	0.506	0.014	0.551	0.042

Sources: Chen, Datt and Ravaillon (1995); Fields (1989); Psacharopoulos et al. (1992), and World Bank (1989; 1996), and author's calculations.

In addition to increasing the Gini coefficients, accounting for environmental damage in the Brazilian case increases the magnitude of change in the coefficient, though, in no case, does it impact upon its direction. In both instances, 1972-79 and 1979-89, the greatest change occurs under the RIA assumption. When one considers that environmental damage relative to GDP was lower in 1979 (2.0 per cent) than in the other two years (2.9 per cent in 1972 and 3.0 per cent in 1989), it is reasonable that fluctuations are greater. The upward adjustment to the Gini is smallest for 1979 (the trough in the Gini-income trend line). Brazil is already known to be among the most unequal countries in the world in terms of the conventional Gini index, and the environmental adjustments only reinforce the observation. The index reaches an almost unthinkable level of 0.690 in 1989 under the RIA assumption.

In contrast to the Brazilian case, however, the direction of change in the Costa Rican Gini – affecting our conclusion on inequality in general – is reversed for the 1981-89 period. The coefficient reaches its low point in 1981 instead of 1989 under both the EMA and the RIA. The reason is exactly as in the Brazilian case: the middle year is the one in which, relative to GDP, environmental damage is least - 3.5 per cent, compared to 7.0 per cent in 1971 and 8.9 per cent in 1989. Yet, in the Costa Rican case, the difference in the damage-GDP ratios is so great that the adjustment to the 1989 Gini coefficient is far greater than that for 1981, under either assumption. The result, contrary to what the conventional statistics tell us, is a renewed increase in inequality during the 1980s. While inequality is by any measure lower in Costa Rica than in Brazil – even the RIA-adjusted indexes are significantly lower than the conventionally measured Gini for Brazil – the more than 55 per cent Gini level indicates moderate to severe inequality.[11]

Table 2a

Brazil: Comparison of Conventional and Depletion-Adjusted Poverty Measures

	Year	Number of Poor (millions)	Headcount Index*	Poverty Gap†
Unadjusted Statistic	1980	16.2	13.3%	3.6%
	1989	28.0	19.3%	6.8%
% increase		72.8%	45.1%	88.9%
Equality of Misfortune	1980	19.6	16.1%	5.7%
	1989	34.2	23.5%	10.5%
% increase		74.5%	46.0%	84.2%
Regressive Impact	1980	23.4	19.2%	10.8%
	1989	34.6	23.8%	15.1%
% increase		47.9%	24.0%	39.8%

Table 2b

Costa Rica: Comparison of Conventional and Depletion-Adjusted Poverty Measures

	Year	Number of Poor	Headcount Index‡	Poverty Gap §
Conventional Gini	1980	138,746	6.1%	3.0%
	1989	6,524	0.2%	0.01%
% reduction		-95.3%	-96.7%	-99.7%
Equality of Misfortune	1980	203,476	8.9%	3.9%
	1989	58,445	2.0%	0.9%
% reduction		-71.3%	-77.5%	-76.9%
Regressive Impact	1980	320,295	14.0%	13.2%
	1989	508,887	17.4%	17.2%
% increase		58.9%	24.3%	30.3%

Sources: Psacharopoulos et al. (1995), and author's calculations

* Percentage of the population that is poor

† Mean shortfall divided by poverty line

‡ Percentage of the population that is poor

§ Mean shortfall divided by poverty line

Even judging from the conventional statistics, Brazil's weak growth during the 1980s had a hand in a general increase in poverty as measured both by the headcount index and the poverty gap (Table 2a). The 45.1% increase in the headcount coupled with population growth of 19.6% results in a 72.8% increase in the absolute number of poor people in Brazil from 1980 to 1989. The poverty gap increased even more in relative terms, almost doubling. Under the EMA, both indexes are higher for both years than in the conventionally-measured case, yet there is virtually no variation in the per cent changes over the decade.

The results in the RIA case are somewhat surprising, with a definite percentage change over the decade. While both indexes are highest in the RIA case, the per cent increases are significantly lower, even when compared to the conventionally-adjusted headcount and poverty gap. The phenomenon is probably due to a peculiarity in the adjustment method where only the poorest quintile loses more in absolute terms under the RIA than the EMA, since this group suffers the lion's share of the damage under the 'inverse income weights' scheme discussed earlier. Consequently, some individuals near the median of the income scale, who were 'made poor' using the EMA environmental-damage adjustment, were not under the RIA. The outcome contradicts Khan's '*a fortiori*' assertion that more regressive environmental impacts necessarily result in conventional statistics understating the respective problems to a greater degree than under the EMA.

The Costa Rican case offers an interesting contrast. Here, poverty declined precipitously during the 1980s, when measured according to either headcount or poverty gap (Table 2b). And while both measures of poverty are substantially higher assuming the EMA, the conclusion that poverty fell during the 1980s holds. Under the RIA, however, the story changes completely. Both the incidence and extent of poverty increase during the decade, even though the 1980 indexes are already much higher than the conventionally-measured numbers.

More than half a million Costa Ricans were poor in 1989 under the RIA, compared to under 7,000 when the headcount index is not adjusted. The poverty gap in 1989 is 17.2%, instead of a mere 0.01%. The reason we obtain such a different conclusion from in the case of Brazil, when comparing the EMA to the RIA, again relates to the much greater disparity in the extent of resource depletion in Brazil from in Costa Rica. The fact that environmental damage in 1989 accounts for 8.9 per cent of Costa Rica's GDP explains much. Under the RIA, every member of the poorest quintile has his income reduced by almost 23 per cent.

Concluding thoughts

In addition to being determined by economic factors, environmental damage itself often produces adverse economic consequences. Specifically, environmental damage may among other things increase inequality and poverty. My results demonstrate that conventional statistics consistently understate the degree of inequality and poverty in both Brazil and Costa Rica, and that accounting for environmental damage reveals greater degrees of both. In the case of Costa Rica, I show that inequality and poverty worsen from 1981 to 1989 when we assume regressive ecological impacts, contrary to what the conventional statistics suggest. Based on the findings, one might conclude that environmental damage to a significant degree limits the effectiveness of GDP growth in reducing deprivation.

What remains uncertain is the degree to which such a general assertion is influenced by the presumed ecological distribution. There is justification for employing the Regressive Impacts Assumption (RIA) in the case of Brazil and Costa Rica, as I have noted. Yet alternative ecological distribution profiles may reasonably be considered instead, potentially altering our conclusions.

Clearly, more attention needs to be devoted to developing innovative techniques that will allow us to measure ecological distribution properly or at least to estimate it reliably and quantitatively.[12] Until such reliable data become available, however, sensitivity analysis around different educated assumptions may be preferable to indexes or aggregates in informing policymakers. Significant variability in the multiple outcomes that might result would appropriately signal the need for caution in the face of uncertainty, while relative consistency across different assumptions would provide more robust evidence than could any one-dimensional indicator.

Martinez-Alier (1993) makes a convincing case that even estimating the dollar value of the social cost - to say nothing of the more direct ecological distribution - associated with environmental damage or resource depletion is an inescapably subjective exercise, since different population groups value the environment differently. Such an observation bodes ill for any hope of assessing inequality or poverty along the lines suggested in this study, though fortunately we need not adopt such an extreme relativist view. Nor, however, should we embrace an opposing extreme perspective – that is, limit ourselves to the narrow conventional statistics that disregard the effects of environmental damage.

Whether the exacerbation of inequality and poverty brought about by environmental damage implies *further* environmental damage as part of a vicious cycle is still very much an open question. The same can be said for the effect of environmental damage on continued GDP growth, and both questions also deserve continued attention and further research. Insofar as inequality or poverty do adversely affect environmental outcomes – in addition to vice-versa – my findings may conflict with earlier optimistic studies finding a direct relationship between GDP growth and environmental quality.

Yet on a brighter note, the results also imply that pro-environment policies can improve national well-being, not only for the obvious environmental benefits that would be preserved, but also because of the inequality and poverty reduction that is likely to be a consequence of such action. Countries like Brazil and Costa Rica are not, in other words, condemned to suffer continued pernicious environmental effects of economic growth. In the absence of an 'equity-environment tradeoff', more aggressive environmental protection today has the potential to generate a 'win-win' outcome for society and future generations.

Notes

[1] Among determinants often considered are income or its growth, inequality and poverty, or other social variables. The Environmental Kuznets Curve hypothesis (EKC)—which posits an inverted-U relationship between income per capita and environmental degradation or pollution—is perhaps the best example (see, e.g., Grossman and Krueger, 1993; 1995; Selden and Song, 1994, and Shafik, 1994). Criticisms of the EKC abound (e.g., Ekins, 1997; Torras and Boyce, 1998), but they are also mostly preoccupied with determinants of environmental damage instead of consequences.

[2] For consistency I will use the term 'environmental damage' to stand as well for environmental degradation, ecological damage, even resource depletion and the like, since the differences among these are not particularly pertinent to the present discussion.

[3] The Dasguptas in the preceding references are distinct individuals.

[4] Even the environmentally-adjusted Gini may understate inequality. Persky and Tam (1990) note that perceptions of well-being are influenced by local status, i.e., one's place in the income distribution of one's reference group. Their empirical study on the United States shows that a Gini index modified to reflect local status showed much less improvement from 1949-79 than did the standard Gini.

[5] See Foster, Greer and Thorbeche (1984).

[6] Of course this assumes that the poverty line or threshold itself is not adjusted. There is scant basis for assuming otherwise, as long as we accept in principle that income adjusted for environmental damage is a more accurate estimate of 'true' income than income without such an adjustment.

[7] An important caveat is that, to the extent that depletion of, say, a country's petroleum reserves produces substantial and deleterious ecological change, the poor may nevertheless be disproportionately harmed. Recent lawsuits by indigenous groups in Ecuador against Texaco and other oil companies are illustrative.

[8] Perhaps the most prominent example is that of deforestation. Others apply, however, as well, such as soil toxification or river silatation. Martinez-Alier (1993) is especially careful to emphasize that the phenomenon (of disproportionate environmental harm to the poor) is entirely related to the poverty of the affected population rather than to any diminished preference for environmental quality on their part resulting from their being poor.

[9] I maintain that it is not unreasonable to do so given the specific country cases. I do not claim that these are the only reasonable assumptions that one can make. As already noted, simplifying assumptions are unavoidable given the paucity of hard data on ecological distribution, a problem that one hopes will be addressed in due course.

[10] Most certainly there is much that can be elaborated about the methodology, assumptions, data sources, etc., corresponding to each study. Such a discussion would be far beyond my present scope, however, since this study is concerned more with demonstrating the influence of environmental damage (assuming that it is properly measured) on inequality and poverty than with establishing an suitable approach for measuring such damage. There already exists a copious literature on the latter subject.

[11] Although one should generally exercise great caution in comparing Gini coefficients across countries because of frequent data inconsistencies (e.g., distribution of consumption instead of income or household as measurement unit instead of individual), the caveat does not apply here, since all observations for Brazil and Costa Rica are measures of distribution of individual gross income.

[12] It should almost go without saying that in appealing for research in this area I am not implying that current statistics on income inequality, poverty, and environmental or ecological damages (independent of their distribution) are sufficient or adequate. Indeed, both significant increases in their availability and improvements in their reliability are vitally important, but it is a matter to be addressed elsewhere.

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