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Aggregate Estimate of Environmental Degradation for Zimbabwe: Does Sustainable National Income Ensure Sustainability?

Abstract: Standard measures of economic growth do not adequately reflect changes in aggregate welfare over time. Sustainable national income is therefore defined as Net National Product with adjustments for the degradation of renewable and non-renewable capital. Productivity loss rather than replacement cost is the most theoretically correct way to value resource depletion. Modified net product is estimated for the agriculture and forestry sectors of Zimbabwe by valuing the loss of forest stock and soil erosion. The results show that traditional measures overstate the value of the agricultural sector's product by approximately 10 percent in 1989. It is argued that indicators of sustainable national income do not ensure sustainable development; as with all macroeconomic indicators, they do not account for distributional and equity issues which are at the crux of sustainable development, nor do they point to mechanisms which would ensure sustainable resource management. Indicators are therefore a necessary but not sufficient condition for the achievement of sustainable development.

INTRODUCTION

It has now been widely recognized that the standard measures of economic growth do not reflect changes in environmental quality or the changing stock of natural capital. The search for better measures at the national level has concentrated on recognizing social goals as part of sustainable development, and incorporating social indicators into measures such as the UNDP's Human Development Index (HDI) (UNDP, 1992). The HDI retains real GNP per capita as the central economic indicator in the index. It is equally necessary, in the search for indicators of sustainability, to correct national income measures in order to avoid the most obvious pitfalls. National income is the economic performance indicator with the central role in macroeconomic policy. A wide body of research has suggested how best to revise this critical indicator.

Even the least radical suggested revisions of adjusting national income for annually observable changes in stocks of renewable and non-renewable resources (Mäler, 1991), pose many obstacles to the estimation of a 'sustainable' national income measure, in that estimates of renewable and non-renewable resource use are imprecise and unreliable, and may be virtually impossible to replicate year on year. In this paper we first review the concept of sustainable income. It is important to highlight that if an economy experiences growth in what is defined as sustainable income, this may mean that the excesses of *unsustainable* resource use may be being minimized, but it does not ensure that a country

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is in a state of sustainable development as sustainable development, in its most widely accepted definition, is a wider concept incorporating ecological security and equity. Estimates of changes in natural capital stock for a single sector in Zimbabwe are presented. These are recognized as partial estimates, dealing only with forestry and soil renewable resources. The results show that the account significantly overestimates the net product of the sector, when the adjustments for capital loss are made. However, although the residual 'sustainable income' is positive, this does not necessarily indicate that Zimbabwe's land using sector is on a sustainable development path, as other necessary sustainable development criteria (such as social equity), may not be fulfilled. Distributional issues and potential land reform policies, as well as the impacts of structural economic reform on the resource base are not encompassed by macroeconomic indicators.

THE CONCEPT OF SUSTAINABLE NATIONAL INCOME

The most quoted principle of sustainable development is that offered by the Brundtland Commission: '...development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987). Two necessary conditions for sustainable development can be identified within the definition of sustainable development. These are intergenerational equity — as implied in the Brundtland definition — and equity in opportunity and human development, which is not only a desirable goal in itself, but is also necessary to safeguard intergenerational equity in resource use.

The implementation of these principles fundamentally leads to environmental and equity constraints on economic optimization. Thus in the context of the case study presented in this paper, a more accurate and sustainable measure of income generated from the agricultural sector does not determine whether the development path is sustainable or not. Sustainable development requires actual compensation for future welfare loss through resource degradation and actual redistribution of resources so that those with least resources are able to sustain their livelihoods. The main processes of land degradation in Zimbabwe are deforestation, overgrazing and soil erosion. There are various interpretations of the driving forces behind this — simple mismanagement of resources or non-allocation of private property rights in communal areas. As distribution of land and resources are crucial political questions in Zimbabwe, as elsewhere, political stances on the fundamental land reform question are often dressed in environmental clothes. Sustainable development demands both social equity and environmental conservation, so the expansion of the argument from sustainable indicators to policies for sustainable development is critical.

The premise underlying resource accounting is, as outlined above, that natural resources are essential to production and consumption for the maintenance of life supporting systems, as well as having intrinsic value in existence for intergenerational and other reasons. This leads to the conclusion that natural capital should be treated in a similar manner to reproducible capital in accounting terms, so that the ability to generate income in the future is reduced, if the stock falls. If a correct value can be placed on natural capital under an accounting system, the implication is that if stocks of natural capital are depleted to increase stocks of reproducible capital and it is assumed that there are no constraints on natural capital use (under a strong sustainability rule for example), then the ability to generate income in the future will be maintained (see Pearce and Atkinson, 1994).

All aspects of renewable and non-renewable resources should be incorporated into adjustments of the national accounting measure (see Adger, 1993). The empirical estimation in this paper is restricted to the agricultural sector accounts so the modifications are of the form:

$$(1)\quad \text{Modified } NNP = C + \dot{K}_M + (P_R - MC_R)\cdot(\delta Q)$$

where $NNP =$ Net National Product, $C =$ aggregate consumption, $K_M =$ reproducible capital stock; $MC_R =$ marginal cost of renewable; $P_R =$ price of renewables; $\delta Q =$ change in stock of renewable resource. The renewable resource degradation investigated is as a result of soil erosion and from deforestation.

RESOURCE DEPLETION IN ZIMBABWE

The relevance of the expansion of national accounts to include environmental capital is more critical in those economies with a high reliance on primary production, and development strategies based on these sectors. Zimbabwe is a natural resource dependant economy. Mining and quarrying accounted for 5.5 percent of GDP and agriculture 10.9 percent of GDP in 1987. The mining sector had decreased relative to the size of the economy in the previous 15 years, from 7.6 percent in 1974, and agriculture had also declined, although it now makes a greater contribution to overall exports. The share of agriculture products and raw materials ranged between 53 and 61 percent in the decade up to 1987. More crucially, up to 80 percent of the total population rely on agriculture as their major economic activity. At independence, in 1980, Zimbabwe inherited a highly skewed dual agricultural sector, characterized as an affluent, mainly white-dominated, large-scale commercial farming sector, with smallholder farming areas farmed by black families. The unequal land distribution aggravates environmental problems in the more densely populated smallholder farming areas. Erosion of the physical agricultural base through soil erosion and deforestation are important considerations in any assessment of the sustainability of income generation in the Zimbabwean economy. Given the importance of the agricultural sector in the Zimbabwean economy, the distribution of income and land leads to soil erosion, in particular, being a sensitive political issue. This sensitivity is further heightened in an era when post-colonial reform of the land-ownership and tenure systems is underway. Macroeconomic indicators do not reflect these distributional issues but rely on data formulated to give policy prescriptions at the sectoral level, must therefore be used with caution. Annual changes in environmental indicators, such as soil erosion and deforestation, are also difficult to assess.

Zimbabwe Forestry Sector

Although much attention is given to conserving present forest stocks in the humid tropics for their global environmental benefits, forests throughout the tropics and the developing world are the major source of primary energy through woodfuel and charcoal. So although deforestation of climax forest and major forested areas is a cumulatively global problem, the problems of obtaining fuelwood at relatively low prices in terms of money or labour is a much more immediate question at a local level. This role of woodfuel is often neglected in energy planning, especially where countries have been trying to develop non-traditional industrial sectors which require large and constant energy sources.

An energy accounting project in Zimbabwe in the 1980s (Hosier, 1986) concluded that a shortfall is likely to occur between the supply and demand for fuelwood, given the then present population and relative price levels in Zimbabwe, by 2000. The reduction of the total stocks of forests each year is the difference between the mean annual increment (*MAI*), which is the increase due to the growth of the existing stock, and the harvest. The estimated aggregate for 1987, shows a reduction in stock of 2.66 million tonnes of dry weight matter equivalent in the time period. This reduction in the stock of natural capital would not appear in the Net Product of Zimbabwe as traditionally measured, though the consequences of the use of other purchased fuels would be registered. If this reduction were to be reflected in a modified Net Product figure, by subtracting the depreciation of the physical stock valued at the rental value (following Hartwick, 1990) then for the forestry sector the following calculation is relevant:

$$(2) \quad NNP = C + \dot{K}_M (P_R - MC_R) \cdot (MAI - Q_R)$$

where P_R = market price for fuelwood; and MC_R = marginal cost of extraction.

The market price of fuelwood per tonne in 1987 (P_R) was estimated to be ZM\$68, taking a weighted average of urban and rural fuelwood prices based on various reported surveys. The imputed cost of extraction of fuelwood per tonne is derived from the estimated time to collect fuelwood in different regions, the shadow price being the minimum agricultural wage. The results are that net product should be reduced by the value of the physical depreciation of ZM\$93.77 million in 1987. If this is borne by the agricultural sector of the Zimbabwean economy, this represents a 9 percent reduction in the net product of the combined commercial and communal areas' agricultural net product as traditionally measured.

Soil Erosion

The value of soil erosion is often quantified in natural resource account studies as it is perceived as a threat to sustaining income and production in the long term, especially in agriculturally based economies. Soil erosion is amenable to estimation through physical models which can be extrapolated across land use data and is generally converted to economic accounts either through productivity loss or through replacement costs of the soil nutrients. The economic cost is generally calculated through two alternative measures.

The *change of productivity* technique uses the value of an erosion-induced yield decline as the damage cost of unabated erosion. It can be used to evaluate on-farm costs (decline of crop yield) and also for the off-farm costs of erosion (decline in irrigation area because of reduced dam capacity). Considering the on-farm costs of erosion, the soil is the relevant stock of natural capital. Its value can be defined as the capitalized net annual income stream generated by producing crops on the soil. The value of the lost production, that is, the change of productivity, reflects the erosion induced damages. The change of productivity technique allows for substitutions at the consumption level, that is, crops that could not be produced can be substituted for by imports of substitute crops. Depreciation of the soil is only considered up to the value of the crops produced on the soil. Previous investments, for instance to ameliorate the soil, are treated as sunk costs. The same applies to the off-farm impacts where only the change in dam yield is considered but not the investment costs of building the dam or a replacement at another location. The change of productivity technique is based on what can be called a weak sustainability constraint. It implies that the sum of natural and man-made capital stocks are non-declining and that substitutions between the two capital stocks are possible. It further allows substitutions at the consumption level. Food produced at a given site can be substituted with food produced at other sites which can lead to a situation where it is economically rational to deplete soil productivity at a given location. Empirical case studies for Mali (Bishop and Allen, 1989), Java (Magrath and Arens, 1989), Lesotho (Bojo, 1991) and Zimbabwe (Grohs, 1994) assessing the on-farm costs of erosion with the change of productivity technique revealed that the net annual costs of erosion are generally less than 1 percent of the agricultural GDP.

The *replacement cost* technique uses the costs that have to be incurred in order to replace a damaged asset. It is based on maintaining a certain stock of natural capital and does not measure the benefits of avoiding the damage. Considering the on-farm costs of erosion, the value of the soil equals the costs of replacing it completely, or at least parts of it, by replacing soil nutrients lost with mineral fertilizer. The replacement cost technique is based on what can be called a strong sustainability constraint. Stocking (1986) estimated the national costs of soil erosion for Zimbabwe with a similar approach based on replacement costs of nitrogen and phosphorus. The costs of erosion with his approach amount up to ZM$1.5 billion per annum (1985 prices), which is more than twice the value of the net agricultural product of the same year.

The purpose of the case study presented here is to determine the sustainable national income from a weak sustainability perspective, hence the productivity loss approach is used. Strong sustainability requires many rigid constraints on the use of renewable and non-renewable resources and substitution between them, and would require an ambitious redefinition of the role of economic growth (see Turner, 1993). In a study on cropland erosion in the smallholder areas in Zimbabwe, Grohs (1993) estimates the productivity loss due to erosion. Soil erosion lowers the productivity of the soil and the change in soil productivity induces an income loss for the farmer because the yields of his crops decline. The aggregate decline in crop yields is used to estimate the annual farm income losses through erosion. In particular, this approach combines three steps. First, average annual erosion rates of cropland erosion for smallholder areas are estimated using an the Soil Loss Estimator for Southern Africa (SLEMSA). The average rate of erosion for Zimbabwe's cropland in the communal areas is estimated to be around 40 t/ha annually, a comparably high soil loss. Second, the impact of erosion on yields is estimated with two soil–plant models. Assumptions on the erosion-productivity relationship (1 percent, 2 percent, or 3 percent yield loss per cm of soil lost) are then based on the model results. The erosion-induced farm income losses are in a third step, calculated with an economic model.

Assuming that erosion induces a 3 percent yield decline per cm of soil lost, smallholder farm income losses for 1988–89 average ZM$4.4 million (Grohs, 1993). The same approach is then applied to cropped land in the large-scale commercial farming sector. Erosion rates are considerably lower (on average 15 t/ha) because the land is less steeply sloped and better conserved. The net annual farm income loss calculated for the large-scale sector is lower and averages ZM$1.7 million. For both sectors, the costs of erosion sum up to about 0.6 percent of the agricultural GDP in 1989.

Agricultural Sector Accounts

The degradation of the resource base of soil and forest stock should then affect the net product as traditionally measured. The agricultural sector accounts are adjusted here in the first instance to reflect the role of that sector as the major location for primary natural resources. The agricultural sector accounts illustrate difficulties which also occur in national accounts. The communal area account, for example, because of lack of data, imputes value to production based on estimates of yields and areas which are not updated each year. The role of subsistence and informal economic activity tends to be ignored in market-based indicators because of this paucity of data. The communal area net product in Table 1 is not disaggregated into returns to the factors.

Table 1 *Modified Net Product for Commercial and Communal Agriculture Sector of Zimbabwe, 1987*

		ZM$ million (1987)
Output		2024
Input		987
Gross Product		1037
Less Depreciation K_M		62
Net Product		975
Less Depreciation K_N		99
Modified Net Product		876
of which	Labour (commercial sector)	333
	Farming Income	372
	Communal Sector	332
	Depreciation K_M	-62
	Depreciation K_N	-99

Sources: Zimbabwe Central Statistical Office (1989) and own calculations.
Note: Part of K_R forms part of Farming Income but is not reported separately. Communal sector accounts are not broken down into disbursement of net product.

Table 1 shows that with soil erosion (ZM$5.65 million (1987)) and forestry depletion (ZM$93.77 million (1987)), the traditional measure of net product for the sector overstates the sustainable contribution of this sector to growth by approximately 10 percent. So although both the communal and commercial farming sectors in Zimbabwe have increased productive sales and the returns to all productive factors impressively in the decade since independence (Thirtle *et al.*, 1993), this traditional accounting overstates the benefit to society in the long run.

DISCUSSION AND CONCLUSION

The need for sustainability modifications to national accounting systems has been recognized as an important contribution to better resource management as well as to the realization that economic growth (as measured by growth in traditional economic indicators) will not necessarily reduce poverty or protect the environment. However, data and estimates of environmental degradation are more unreliable than traditional macroeconomic indicators because of additional classification and estimation difficulties. Many types of environmental damages are only weakly documented and the linkages between environmental degradation and welfare impacts are often unclear. Even if the damages and linkages were known, it is still difficult to assign monetary values to these modifications. Finally, even if economic values can be assigned to the damages, it remains difficult to interpret them. The valuation of the existing stock of resources is still controversial.

Only *potentially* sustainable income is defined in making these adjustments. As an objective of economic policy, increasing the flow of sustainable income is desirable, and would serve to internalize the value of environmental assets into macroeconomic calculus. It will not, however, necessarily bring about *sustainable development*, because it does not address intragenerational equity issues or deal with exported environmental pollution. In short, sustainable development is a complex process which requires the recognition of the subjective positions of the decision-makers:

> ...economists need explicitly to recognise that sustainability is an equity question being debated in various moral discourses utilizing ecological reasoning and that sustainability will be chosen through politics (Norgaard, 1992, p.95).
> The degradation of the physical agricultural base through soil erosion and deforestation are important considerations in any assessment of the sustainability of income generation in the Zimbabwean economy. However, the questions of sustaining the level of natural resources is inextricably linked to the ownership and control of those resources (especially land), and hence to the distribution of the income, in the post-colonial period in Zimbabwe. As with all macroeconomic analyses, these issues are not addressed in the estimation sustainable income indicators. Thus the formulation and estimation of such indicators are a necessary but not sufficient condition for the achievement of sustainable development.

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DISCUSSION OPENING — Angelos Pagoulatos *(University of Kentucky, USA)*

The attempt to estimate the Modified Net Product for the agriculture and forestry sectors of Zimbabwe is consistent with the effort to refine the concept of Net National Product by accounting for the economic depreciation of exhaustible but renewable resources. In this paper, on-site soil erosion and fuelwood costs are addressed. It is not surprising to see the conclusion that a traditional macroeconomic indicator for welfare accounting is not able to reflect sustainable resource management. The underlying factors for achieving sustainable resource management and sustainable development must be found in the causes of environmental deterioration. Several factors may cause environmental deterioration, such as social and cultural factors, population growth, and economic conditions and policies. These factors create the incentives for current patterns of resource use and therefore a change in some of these factors, through policy actions designed to redirect incentives or eliminate price distortions, could be sufficient to achieve reductions in environmental deterioration. Examples of some economic factors are the international prices for important exports and imports, domestic agricultural and forest product prices, subsidies and taxes and alternative energy source national policies etc. Appropriate indicators for sustainability could then, and should be, identified to monitor the redirection of these factors as they provide necessary incentives for sustainable resource use.

It is understandable that limited data did not allow for more precise calculations and inclusion of secondary and off-site costs. The change-in-productivity approach to value environmental cost is appropriate. It is the concept of opportunity cost, which refers to the best alternative use, that is not followed in the determination of environmental costs. Rather, a concept of comparing present use to an assumed sustainable yield level which would produce no environmental deterioration is used in quantifying costs. Thus, all agricultural income foregone from declining soil productivity, through lower crop yields, is measured regardless of whether this sustainable alternative associated with zero environmental deterioration is viable and realistic. If it is not viable and realistic, the estimates of on-site soil erosion costs are overstated. Should sustainable resource use disregard the concept of opportunity cost?

Finally, the estimates presented in the analysis represent average values used, with no caveats. The use of average, rather than marginal, values can produce over or under estimation. Using average figures for soil productivity would over estimate the opportunity of cost soil productivity if land (soil productivity) is not scarce (the opposite if land is scarce). If scarcity of land (soil productivity) is to become relevant at some future date, then the current cost should include a user cost. The user cost would be smaller the further that date is into the future and the larger the discount rate used.