THE YIN AND YANG OF SUSTAINABLE DEVELOPMENT: A CASE FOR WIN-WIN ENVIRONMENTALISM

by

James Roumasset and Lee Endress *

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Over the last decade, the notion of sustainability has become almost an international mantra as governments, private organizations, and multilateral institutions seek to pursue development policies that are more environmentally friendly. At the same time, the belief that growth and environmental stewardship are fundamentally in opposition led to the emergence of *ad hoc* approaches to the perceived problem. Beginning with the World Commission on Environment and Development ("the Brundtland Commission," 1987), however, a growing awareness has developed that environmental degradation is intimately linked to poverty and population pressure in developing countries.

The Malthusian vicious circle between poverty and population pressure is embedded in a larger vicious circle involving environmental degradation. Malthusian forces increase pressure on environmentally fragile resource systems (e.g. hillside watersheds). As these systems are degraded, both on-site effects such as soil erosion and off-site effects (e.g. siltation of irrigation systems) further exacerbate the original Malthusian dilemma. The Commission concluded that the way out of this immiserating yet resilient system of reinforcing feedbacks was a simultaneous push to growth the economy, reduce birth rates, and conserve (but not necessarily preserve) natural resource including environmental quality.

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* Professor and Affiliate Faculty Member, Economics Department, University of Hawaii at Manoa. respectively.

1. Sustainable Growth

Most attempts to model sustainable economic growth took the term quite literally -- as growth that is sustainable. Sustainability was taken to mean that an additional constraint must be added to models of optimal growth.

In a relatively early effort, Pearce, Barbier, and Markandya (1990), specified sustainbility as a constraint on the depletion of natural capital. This approach was not embraced by economists because of its arbitrariness and overly preservationist orientation. In particular, the criterion rules out efficient depletion of natural capital in order to finance the accumulation of produced capital. A country's depletion of non-renewable resources would be limited by the extent to which it could accumulate an equal value of renewable resources at all (Dasgupta and Mäler, 1991). But even in the case of renewable resources, maintaining stock levels may not be prudent (".....there is nothing sacrosanct about the stock levels we have inherited from the past"). Similarly, Solow (1986) observes that "The current generation does not especially owe to its successors a share of this or that particular resource. If it owes anything, it owes generalized productive capacity or, even more generally, access to a certain standard of living or level of consumption."

A more widely accepted version of the sustainability constraint is that of "weak sustainability", according to which it is total capital that must not decline in value, i.e. decrements in natural capital must be offset by additions to produced capital. Pearce (1994) recommends the stricter constraint on natural capital ("strong sustainability"), however, because of limited substitutability between natural and manmade capital, scientific uncertainty about the role environmental systems play in the economy, and potential irreversibilities related to ecological degradation. But, these concerns do not imply abandoning weak sustainability in favor of a potentially welfare-reducing rule-of-thumb. The substitutability between natural and produced capital, uncertainty, and potential irreversibilities will affect the value of both forms of capital. In the limit, for example, when the elasticity of substitution between the two forms of capital is zero, weak sustainability implies strong sustainability, i.e. the value of total capital can only be maintained by maintaining the value of natural capital.

Moreover, the weak sustainability constraint can be derived as a necessary condition for sustaining utility levels. After all, it is the well-being of future generations that is the focal point of the sustainability concern. There would not be much point in maintaining stocks of capital, for example, if that constraint hastened the age of diminishing levels of living or accelerated the rate of utility decline, once that age arrives. Hartwick (1978) and Solow (1986) have shown that in a model with neither technological change nor population growth, Cobb-Douglas production as a function of labor, produced and natural capital (but no renewable resources), extracting the non-renewable resource according to the Hotelling efficiency rule and investing the resource rents in the accumulation of produced capital results in a constant level of consumption over time. Thus if the goal of sustainability is taken to imply Solow's interpretation of intergeneration equity (equal consumption across generations), then sustainable utility implies the maintenance of total capital. More generally, maximizing an intertemporal utilitarian welfare function of the form,

(1) $$W = \int_0^\infty U(c_t)\, e^{-\rho t}\, dt,$$

where $U(c_t)$ is the utility of consumption in time, t, and ρ is the utility discount rate, results in the Hotelling-Hartwick-Solow rule for maintaining the total value of capital, provided that the elasticity of the marginal utility of income is infinite (Nordhaus, 1992; Endress, 1994).

Maximizing W with said elasticity set equal to infinity is also equivalent to replacing the utilitarian welfare function with Rawls' maximin criterion. But there is no clear reason for specifying a welfare function that incorporates an infinite degree of risk aversion towards variations in intertemporal consumption. Indeed, Rawls (1971) himself notes that the maximin criterion is inappropriate for the case of an infinite horizon (see also Nordhaus, 1992). Finally, the maximin criteria leaves countries at the mercy of their initial capital stock (Dasgupta and Heal, 1979). Countries that are capital poor are forever constrained to have low levels of per capital consumption.

Accordingly, Toman et. al. (1994) model sustainability as a constraint on consumption. The social planners' problem is seen as maximizing the utilitarian welfare function specified above, subject to the constraint that consumption can never decline. When this "opsustimality" criterion is applied to the Hartwick-Solow economy, the following rule is derived: accumulate total capital according to the welfare criterion so long as the change in the value of total capital remains positive; once capital accumulation declines to zero, switch to the Hotelling-Hartwick-Solow rule. Unfortunately, the appeal of opsustimality does not necessarily extend beyond the Hartwick-Solow economy. For example, if the elasticity of substitution between produced capital and a non-renewable resource is less than one, it is impossible to prevent consumption from declining (Dasgupta and Heal, 1977). For this economy, the opsustimality criterion is incapable of ranking alternative consumption paths. Moreover, the criterion does not make clear why it would ever be appropriate to set the utility discount rate above zero.

As Frank Ramsey argued almost 70 years ago, it would be ethically indefensible in the pursuit of efficiency to discount utilities of individuals in future generations. This does not imply, as widely believed, that discounting should be eschewed in cost-benefit analysis, only that social welfare should not give greater weight to those in the present generation. The discount rate in project evaluation is the value of loanable funds at the distorted equilibrium, i.e. it is an equilibrium concept. Given sufficient possibilities of increasing consumption tomorrow by deferring consumption today, the project discount rate will be positive, even if the utility discount rate is zero.

In an earlier paper (Endress and Roumasset, 1994), we investigated optimal growth in a generalized version of the Hartwick-Solow economy, including the possibility of a zero utility discount rate. Instead of a fixed amount of the non-renewable resource available at a constant extraction cost, we assumed that extraction costs rise as a function of cumulative resource use. Demand for conventional resources is limited by a "choke price" equal to the cost of using an unlimited resource such as solar energy (Epple and Londregan, 1993). When the utility discount rate is set equal to zero, this model leads to a straightforward generalization of neoclassical growth theory. The resource is extracted according to an extended Hotelling principle (resource royalty equals the marginal user cost associated with foregoing future use). Resource rents are augmented by deferred consumption to finance capital accumulation that satisfies the Ramsey savings condition (marginal rate of substitution between present and future consumption equals its marginal rate of transformation). These conditions imply that capital per head accumulates until its marginal product falls to the combined rates of population growth and depreciation. Consumption rises monotonically and asymptotically to a golden rule steady state.

This result has been further generalized to the case of renewable resources (Endress, 1994). In this case, the renewable resource is managed according to an appropriately generalized Hotelling condition (marginal user cost includes the higher future extraction/harvesting cost and lower natural growth rate caused by increasing the stock today). If its natural growth at the steady state level renders the renewable resource cheaper than a backstop substitute, the renewable resource will be redundant. Again consumption rises asymptotically to a golden rule steady state level. Correspondingly, the value of total capital rises throughout, such that the capital labor ratio also approaches its golden rule level. For both the renewable and non-renewable golden rule models, sustainability constraints of either the capital stock or consumption growth variety are therefore redundant.

In summary, the essence of sustainability is to avoid increasing present consumption at the expense of future generations by implicitly according lower welfare weights to the future. Once this "weakness of the imagination" (Ramsey, 1928)[1] is overcome, the case for sustainability constraints evaporates. In a generalized Hartwick-Solow model, with or without renewable resources, sustainability constraints would be non-binding for any elasticity of substitution between produced and natural capital that is greater than or equal to one. If the elasticity is less than one,

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[1] Quoted in Heal (1993). Heal also notes Harrod's (1948) comment that utility discounting is "a polite expression for rapacity and the conquest of reason by passion."

the constraints could only be met by setting consumption equal to zero for all time.[2] Nor does specifying sustainability as a minimum consumption constraint capture the notion of concern for future generations. When such a constraint is both feasible and binding, it benefits current generations at the expense of future ones.

We have suggested instead that concern for the future and other intergenerational equity issues are adequately handled by intergenerational neutrality and by the Benthamite condition of maximum aggregate satisfaction. This leads in turn to the choice of neoclassical growth theory as the appropriate theoretical framework and to a generalization of Hartwick's Rule. Instead of extracting the resource efficiently and investing the proceeds in produced capital in order to keep the total value of capital intact, the new rule calls for saving even more than resource rents, in order to equate the marginal rates of substitution and transformation across generations, and increasing the value of capital per head up to its golden rule level.

2. Win-Win Environmentalism: Getting the Incentives Right

Since neoclassical growth theory abstracts from possible inefficiencies in resource extraction, its application calls for the complementary investigation into policy reforms designed to reduce economic waste. Examples of waste in environmental and natural resource management abound in Asian countries and elsewhere in the world (see e.g., World Bank, 1992, Pearce and Warford, 1993, Panayotou, 1993, and Repetto, 1989). For example, water and logging concessions are almost universally underpriced. In South and Southeast Asia, irrigation water is priced on average at only 10% of its full long-run marginal cost (Repetto, 1986;

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[2] Dasgupta and Heal, 1979.

Roumasset,1987). In the case of trees and groundwater (both renewable resources), user fees are set at levels that do not account for user cost, i.e. the loss in the present value of the resource due to its depletion. As a result, these resources are priced on the order of 20% or less of their true value. Another class of examples relates to externalities such as air and water pollution, downstream effects of soil erosion, water logging and salinity problems relating to excess irrigation and insufficient drainage, and urban congestion.

Most of these cases involve violations of the fundamental condition for efficient resource use,

$$(2) \qquad MB = C + MUC + MEC \,,$$

where C = extraction (or harvesting) cost, MUC = marginal user cost, and MEC = marginal externality cost. While this equation is a form of the central principle of economic efficiency, i.e., increase an activity up to the point that marginal benefit equals marginal cost, its derivation for a particular environmental problem may not be a trivial pursuit. Consider, for example, the problem of the efficient spatial allocation of irrigation water. Even abstracting from externalities and the dynamic problem of optimal storage (so that the terms MEC and MUC drop out), the remaining requirement to equate marginal benefits of irrigation water with its long-run marginal cost must be simultaneously satisfied at multiple margins in order to determine optimal headworks capacity, optimal conveyance (e.g. lining of canals), and optimal distribution across users. Solving such problems for particular cases may require collaboration between economists and agricultural engineers.

The second category of examples involves the management of resource stocks. Abstracting from externalities and transposing extraction cost to the left side of equation 2, we have the generalized Hotelling condition from section 1, i.e. resource royalty equals marginal user cost. Actually evaluating marginal user costs (i.e. the change in present value of a stock associated with an additional unit of depletion) may require a somewhat complex calculation, however, especially where the resource is not being efficiently depleted or accumulated. (Note that the proposal that renewable resources be maintained at existing stock levels would only be correct if the economy were already at an efficient steady state). Nonetheless the formula is readily available (see e.g. Endress, 1994).

The problem of managing static externalities focuses on the third term on the right hand side of equation 3. Suppressing C and MUC, we have the condition that the marginal benefits to the polluter equals MEC (also known as the "marginal damage cost"). Again the application of the principle of equating marginal benefits and costs involves simultaneous satisfaction along multiple margins. In a multiple source-receptor model of air pollution for example, the condition requires that the net marginal benefit of pollution to each pollution source be equated with the marginal damage cost (MEC) to each victim. Since there may be a large number of both sources and victims, this condition may be required for an unmanageable number of source-receptor pairs. This helps to explain why the most incentive-compatible air-pollution management scheme that has been implemented thus far, emission trading, involves a serious compromise with efficiency, except in the unlikely event that a unit of emission, regardless of the source, results in the same exposure, regardless of the receptor. It is possible to design institutions capable of implementing a more efficient solution, but again that is not a trivial exercise nor one whose results are readily communicated (see Roumasset and Smith, 1990, for a specific proposal).

An additional problem with implementing efficiency conditions is one of measurement. Placing a value on health risks, climate change, existence, and biodiversity is fraught with both conceptual and informational difficulties. The problems of derivation, implementation and measurement are thus all impediments to policy reform. But solving these problems promises potentially enormous social payoffs.

A further problem is one of optimal organization, recognizing that the costs of achieving the first-best optimum described by MB=C+MUC+MEC may be prohibitive. Optimal organization calls for minimizing agency costs, i.e. equating the marginal reduction in excess burden from organizational investments in approximating the first-best condition with the costs of such investment. The problem of whether to facilitate privatization of common property resources represents an example of this second-best problem. The prevalence of publicly owned forest lands in the Philippines and Indonesia, for example, where slash and burn agriculturalists and the political elite face inadequate restraints from either private owners or community control, suggests potentially large gains from aligning incentives with the second-best efficiency conditions. It is likely that in situations where commercial logging would be marginally profitable at best, once the full user and environmental costs are factored in, that indigenous populations may have a comparative advantage in guarding against overlogging and that such guarding incentives can be best created by conferring "stewardship rights" on them for selective logging and horticultural cultivation.

c. Concluding Remarks

Sustainable development has more than a hundred definitions and has been assessed by leading economists as a vacuous, or at best vague, concept. Moreover, the sustainability debate is a recycled version of the nearly centuries old controversy between the dismal economist, Thomas Malthus, and visionary French philosopher, the Marquis de Condorcet. Noble Laureate Robert Solow has suggested that "sustainability is an injunction not to satisfy ourselves by impoverishing our successors." That does not imply, as suggested for example by Pearce et al. (1990), that the stock of the planet's natural capital should not be diminished. Levels of living can be sustained, for example, by substituting physical capital for natural capital. In the pessimistic view that there is zero substitutability between natural and physical capital, it is infeasible to sustain levels of living, by preserving stocks of natural capital or by any other means, unless one employs the deus ex machina of technological change.

The key to prudent conservationism is to utilize natural resources efficiently. As Frank Ramsey argued more than sixty years ago, however, it would be ethically indefensible in the pursuit of efficiency to discount future utilities of individuals. This does not imply, as is widely believed, that discounting should be eschewed in benefit-cost analysis, only that social welfare should not give greater weight to those in the preset generation. Under plausible assumptions, one can show that a Ramsey-type objective function implies the gradual drawdown of both renewable and non-renewable resources. This drawdown facilitates sufficient capital formation such that levels of living are permitted to rise continuously, asymptotically approaching a "golden-rule" steady state, in which non-renewable resources have been economically exhausted and renewable resources have been depleted to the point of their optimal stocks.

Environmentalists often assume that an increase in material consumption necessarily comes at the expense of environmental amenities. Such a hypothetical trade-off corresponds to moving Southeast along the production possibility curve illustrated in figure 1. In actuality, however, due to the extensive inefficiencies documented above, the status quo equilibrium lies well inside the frontier. What environmentalists are really reacting against are further rent-seeking actions such as the well-known case of subsidized Brazilian ranching operations (see e.g. Panayotou, 1993), which dramatically eroded hillside soils and were commercial failures to boot. But the preservationist alternative fails to provide sufficient capital formation to reduce poverty and thus eventually fails to preserve the environment as well. Both rent-seeking and preservationism are driven by fear of scarcity and a zero-sum game mentality. By focussing instead on win-win reforms, the principles of scarcity can be used to create abundance (figure 2).

It is not capitalistic markets *per se* nor the single-minded pursuit of efficiency which immiserates the people of the world. In each and every case, real world governments create artificial scarcity by regulating voluntary exchange and restraining the human spirit. In each and every case, the motivation is the same -- the pursuit of rules-of-the-game which confer special privileges on the ruling coalition (rent-seeking). These rules are invariably shrouded in politically appealing rhetoric about how they benefit one victimized group or another. Invariably such restrictions do the opposite by shrinking the economic pie, intensifying the squabble over its division intensifies so that the preponderance of (win-lose) players end up getting less. The remedy is replacing the fear of scarcity with an understanding of scarcity. Artificial scarcity is created when fear drives the futile pursuit of personal abundance through the creation of privilege, which in turn creates waste. When transparency is used to allow scarce resources to find their highest and best use, abundant opportunities for progress can be created for all segments of society, not just the privileged elite.

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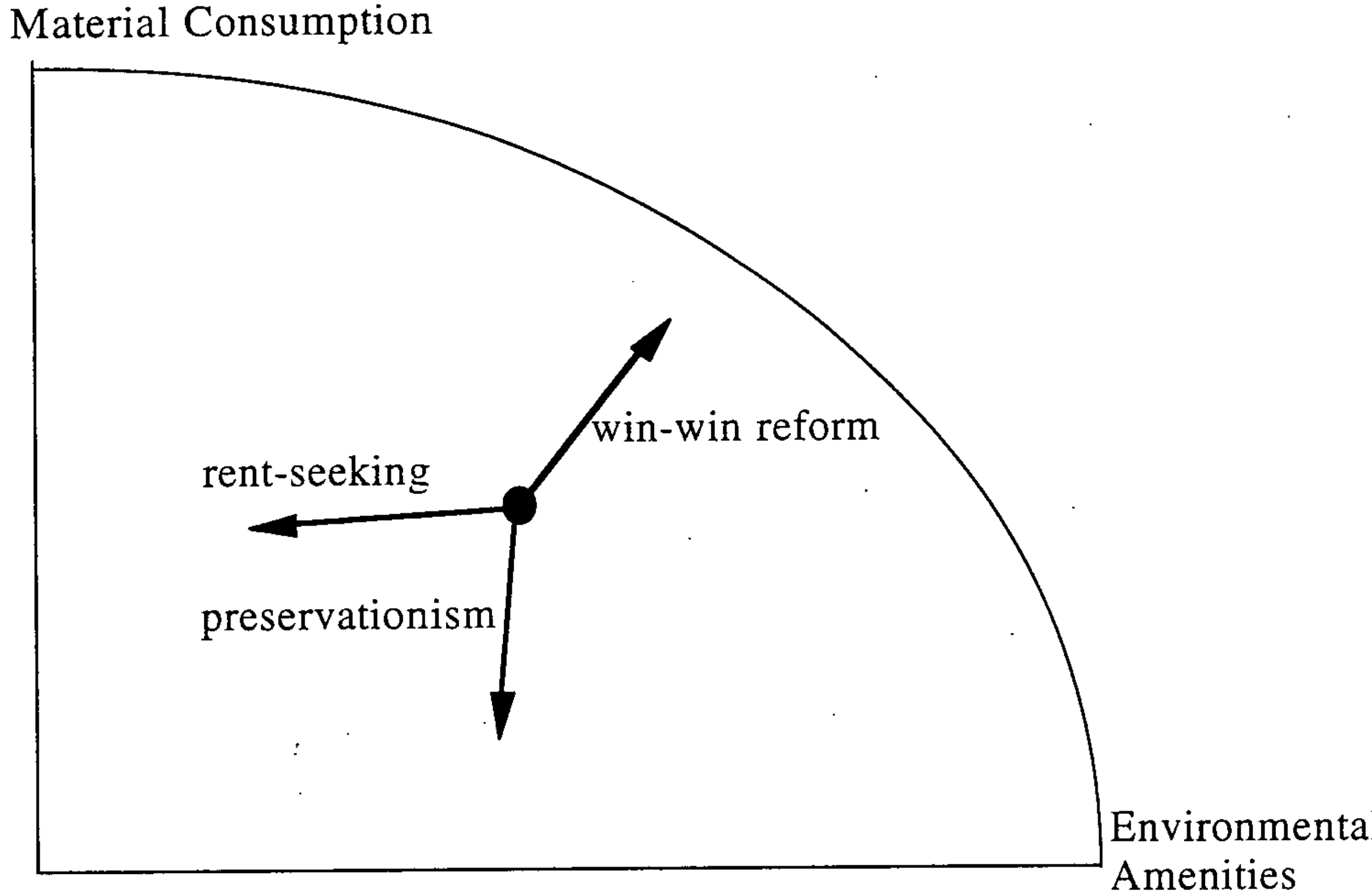

Figure 1: Three Strategies for Sustainable Development
(Can you guess which one works?)

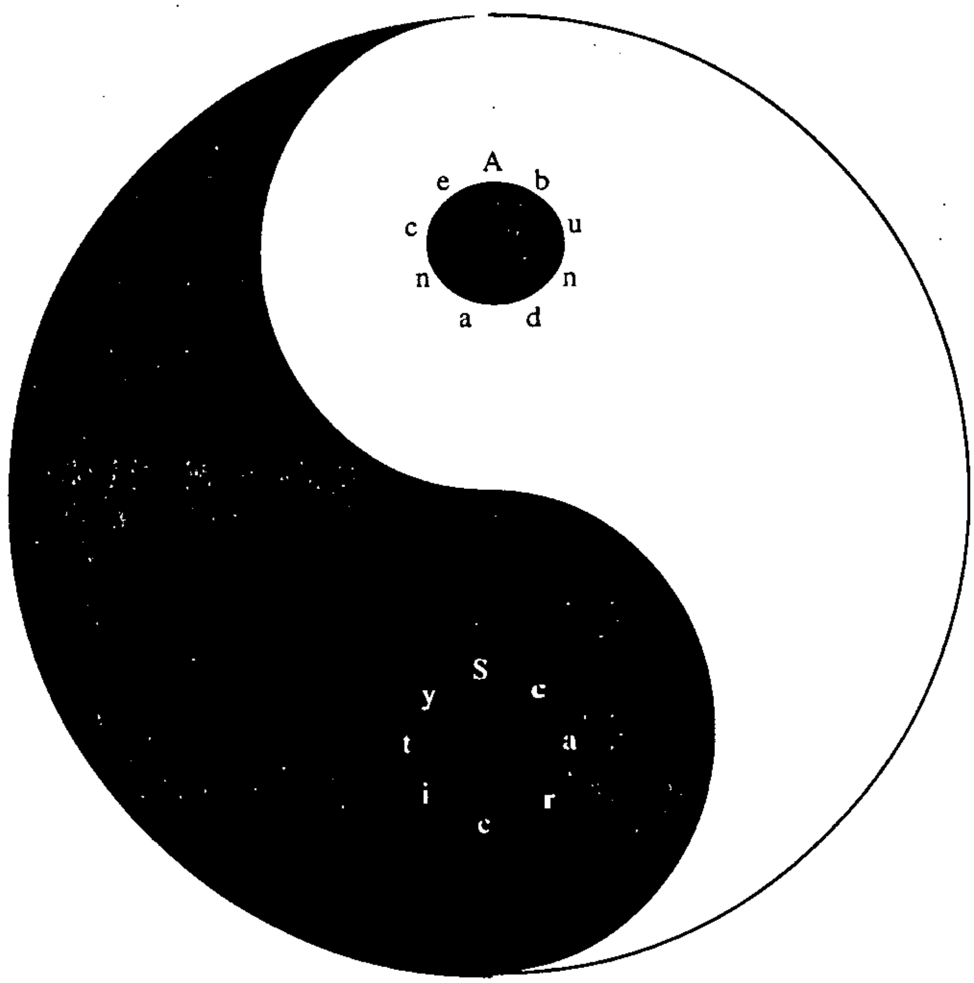

Figure 2: The Yin and Yang of Sustainable Development