



Human Development and Economic Sustainability*

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Summary. — This paper attempts to integrate the concern for human development in the present with that in the future. In arguing for sustainable human development, it appeals to the notion of ethical “universalism”—an elementary demand for impartiality of claims—applied within and between generations. Economic sustainability is often seen as a matter of intergenerational equity, but the specification of what is to be sustained is not always straightforward. The addendum explores the relationship between distributional equity, sustainable development, optimal growth, and pure time preference. © 2000 Elsevier Science Ltd. All rights reserved.

1. FUTURE PROSPECTS AND PRESENT LIVES

“It is justice, not charity, that is wanting in the world,” wrote Mary Wollstonecraft, the pioneering feminist, in *A Vindication of the Rights of Woman*, published in 1792, the same year in which her friend Thomas Paine published the second part of the *Rights of Man*. Both were concerned with giving everyone—women and men—power over their own lives and opportunities to live the way they had reasons to value. One particular feature of their common approach is particularly worth emphasizing in the context of policy discussions today, *viz.* the implicit “universalism” that characterizes both the approaches. The domain of concern is not arbitrarily restricted to, say, men, or men of a certain class or background. This shared aspect of the original contributors to the human rights approach is of specific interest in interpreting the task of “human development” in a world that is marked, on the one hand, by enormous inequities in contemporary living conditions, and on the other, by real threats to the prospects of human life in the future.

Appeals to rights and entitlements that have moved the world forcefully have often tended to ignore the freedoms of particular groups.

For example, while ancient Greek philosophers presented some of the most far-reaching analyses of individual independence and autonomy, they typically did not hesitate to leave out the slaves—and often women too—from the discourse. The language and the rhetoric as well as the reality of rights in the contemporary world are often characterized by the neglect of particular sections of the population—less privileged ethnic groups, exploited classes, sequestered women.

The basic idea of expanding “human capability,” or of “human development,” which has been pursued in different forms in recent years, involves the assertion of the unacceptability of such biases and discrimination.¹ We shall not spend any time here on the issue of whether formalisms used in successive *Human Develop-*

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ment Reports do full justice to the idea. But its focus on universalism is something of importance for contemporary debates on public policy. The growing concern with “sustainable development” reflects a basic belief that the interests of future generations should receive the same kind of attention that those in the present generation get.²

We cannot abuse and plunder our common stock of natural assets and resources leaving the future generations unable to enjoy the opportunities we take for granted today. We cannot use up, or contaminate, our environment as we wish, violating the rights and the interests of the future generations. The demand of “sustainability” is, in fact, a particular reflection of universality of claims—applied to the future generations *vis-à-vis* us.

That universalism also requires that in our anxiety to protect the future generations, we must not overlook the pressing claims of the less privileged today. A universalist approach cannot ignore the deprived people today in trying to prevent deprivation in the future.

One of the strongest arguments in favor of giving priority to the protection of the environment is the ethical need for guaranteeing that future generations would continue to enjoy similar opportunities of leading worthwhile lives that are enjoyed by generations that precede them. This, as we discuss in Section 3 of this paper, is the central idea underlying the demand for “sustainable development,” and it has many important implications. But this goal of sustainability—increasingly recognized to be legitimate—would make little sense if the present life opportunities that are to be “sustained” in the future were miserable and indigent. Sustaining deprivation cannot be our goal, nor should we deny the less privileged today the attention that we bestow on generations in the future.

The living standard of a substantial part of humanity has radically moved forward in a way that would have been hard to anticipate in Paine’s or Wollstonecraft’s time. While it would have been, then, difficult to dispute that human life everywhere was “nasty, brutish and short” (as Thomas Hobbes had put it in *Leviathan*), people today in many countries in Europe, North America and elsewhere have lives that are much longer, less miserable, and far less battered by forces beyond the person’s control. Yet a great many people in the world continue to suffer from the absence of fundamental opportunities to lead decent and satis-

fying lives. The continued high incidence of premature mortality, ill-health, undernourishment, illiteracy, poverty, insecurity, and other forms of deprivation indicate the failure of the modern world to bring even the most basic capabilities within the reach of all. A newborn child may be doomed to a life of extreme brevity or intense misery if that child happens to be born in a “wrong class,” in a “wrong country,” or to be of the “wrong sex.”

Ethical universalism is basically an elementary demand for impartiality—applied within generations and between them. It is, in the present context, the recognition of a shared claim of all to the basic capability to lead worthwhile lives. Not working toward guaranteeing the basic capabilities to the future generations would be scandalous, but in the same way, not working toward bringing those elementary capabilities within the reach of the deprived in the present generation would also be outrageous. Given the implicit biases in many policy debates, there is a real need for jealously guarding that universalist perspective.

As the full significance of the issues forcefully discussed in the environmental conference (UNCED) in Rio in 1992 begins to be more fully understood, the integration of human progress and environmental conservation has emerged as one of the central challenges faced by the modern world (Pronk & Haq, 1992; Speth, 1992; Brundtland, 1993). The moral value of *sustaining* what we now have depends on the *quality* of what we have, and the entire approach of sustainable development directs us as much toward the present as toward the future. There is, in principle, no basic difficulty in broadening the concept of human development to accommodate the claims of the future generations and the urgency of environmental protection.

2. ALTERNATIVE DEVELOPMENT APPROACHES

(a) *Human development and wealth*

The foundational task of scrutinizing the demands of sustainable human development also provides an appropriate occasion to see how the “human development” approach relates to the more conventional analyses to be found in the standard economic literature—from Adam Smith (1776, 1790) onwards. Interest in human development is not new in

economics. Indeed, this motivating concern is explicitly present in the writings of the early founders of quantitative economics (such as William Petty, Gregory King, François Quesnay, Antoine Lavoisier, and Joseph Lagrange) as well as the pioneers of political economy (such as Adam Smith, David Ricardo, Robert Malthus, Karl Marx, and John Stuart Mill).³ There is, in this sense, no foundational departure in making economic analysis and policy take extensive note of the demands of human development. The approach reclaims an old and established heritage, rather than importing or implanting a new diversion.

Economics has never been a subject of one tradition only. The interest in human development has had to compete with other priorities and pursuits within the same body of mainstream economics. The preoccupation with commodity production, opulence and financial success can also be traced in professional economics through several centuries—involving many leading economists as well as businessmen and bureaucrats, who have preferred to concentrate more on the characteristics of overall material success than on the deprivation and development of human lives. Indeed, the dominant contemporary tradition of focusing on such variables as per capita gross national product or national wealth is a continuation—perhaps even an intensification—of the old opulence-oriented approach.

The focus on wealth maximization can be taken at different levels, and at the common aggregative level, the spotlight is put entirely on making the community as a whole as opulent as possible, irrespective of distribution and irrespective of what that wealth does to human lives. It is, of course, true that being rich, wealthy and affluent can be among the most important contributory factors in generating well-being, and the opulence-oriented approach to economic progress certainly cannot be criticized for being irrelevant to the success of human living. On the other hand, insofar as it neglects other crucial factors, such as public care and social organization, which also contribute to the well-being and freedom of individuals, the approach is deeply limited and defective.⁴ Insofar as the concern is with overall wealth maximization—irrespective of distribution—there is a serious disregard of individual predicaments in favor of some conglomerative achievement, which can be blind to the most extreme deprivations suffered by many, while others make use—possibly

excellent use—of the accomplishment of wealth and opulence.

Thus, the fundamental difficulty with the approach of wealth maximization and with the tradition of judging success by overall opulence of a society is a deep-seated failure to come to terms with the universalist unbiasedness needed for an adequate understanding of social justice and human development. In this sense, the wealth-based approach is not, by any means, inconsequential, but it certainly is significantly partisan. The most basic problem with the opulence view is its comprehensive failure to take note of the need for impartial concern in looking at the real opportunities individuals have. The exclusive concentration only on incomes at the aggregative or individual levels ignores the plurality of influences that differentiate the real opportunities of people, and implicitly assumes away the variations—related to personal characteristics as well as the social and physical environment—in the possibility of converting the means of income into the ends of good and livable lives which people have reason to value.

(b) *Objectives and instruments*

How illuminating is the difference between the two traditions of focusing respectively on (i) development of human capability, or human development, and (ii) overall wealth and opulence? These traditions can be seen as differing, directly or indirectly, in two distinct respects. The first concerns divergences in the ultimate *objectives*, and the second relates to differences in the effectiveness of distinct *instruments*.

While the human development approach has conformed broadly to the line of reasoning enunciated by Aristotle more than two millennia ago (“wealth is evidently not the good we are seeking, for it is merely useful and for the sake of something else”), there have been many professional experts who have seen their task as being confined to the maximization of opulence (an old illustration is the 17th century monograph by the pioneering mercantilist author, Thomas Mun, *England's Treasure by Foreign Trade, or the Balance of Our Foreign Trade is the Rule of Our Treasure*). That division about our basic objectives still surfaces in the debates on current policies in different parts of the world, and also in discussions about what importance to attach to various indicators and criteria of progress (such as GNP per capita).⁵

At the level of objectives, the case for following Aristotle rather than Mun is not hard to appreciate. How can we possibly give priority to the *means* of living, which is what treasures and wealths are, over the *ends* of good and free human lives? While much of economic and financial writing proceeds as if there is nothing beyond opulence with which we need be concerned, it is fair to see that as a problem of presentation, rather than a reflection of some deep-seated eccentricity about ends and means. The really interesting debates must relate to instrumental effectiveness of overall wealth and opulence in promoting those things for which wealth and opulence are sought.

There is, in fact, much more substance in the opulence-centered approach than the implausible view that opulence is an end in itself. This takes us to the second difference, which relates to the cause-effect relationships in the pursuit of the deeper objectives. Some have taken the view that while opulence is not to be valued at all for its own sake, it still is the most important instrument in promoting the more basic objectives—even the Aristotelian one of rich and fulfilling lives.

To take a prominent example, W. Arthur Lewis, one of the leading modern development economists, did not entertain much doubt that the appropriate objective to pursue is increasing “the range of human choice.” He also acknowledged the causal role of many factors in advancing the freedom to choose. But nevertheless he decided to concentrate specifically on “the growth of output per head,” because it “gives man greater control over his environment, and thereby increases his freedom” (Lewis, 1955, pp. 9–10, 420–421). Indeed, the focus of his classic book was sufficiently precise to permit him to assert: “Our subject matter is growth, and not distribution.”

Lewis’s faith in the instrumental efficacy of total growth has proved to be quite disputable in terms of the experiences observed in the actual world. Many countries have grown fast without a commensurate impact on living conditions, and more importantly, some countries have achieved high quality of life despite relatively moderate growth of GNP or GDP per head. It has also been observed that even when there is a generally positive and statistically significant relationship between GNP per head and indicators of quality of life in the gross intercountry data, much of that relationship turns on the use of extra income in the

specific fields of public education and health, and in reducing absolute poverty.

It is certainly true that the higher the average income of a country, the more likely it is—given other things—that it will tend to have a higher average life expectancy, lower infant and child mortality rates, higher literacy, and in fact, a higher value of the “human development index.” A number of recent studies have confirmed this general pattern. The associations are, however, far from perfect. For example, in intercountry comparisons, income differences tend to explain not much more than half the variations in life expectancy, or in infant or child mortality, and they explain a smaller proportion of variation in adult literacy rates.⁶ Many countries, such as Sri Lanka, China, Jamaica, Costa Rica, and the state of Kerala in India, have achieved levels of human development that are enormously higher than what would be expected on the basis of their GNP or real income per head.

What is also of importance—perhaps even more so—is the route through which growth of GNP most effectively influences human development. Economic growth not only involves increase in private incomes, it can also significantly contribute to generating resources that can be marshalled to improve social services (such as public healthcare, epidemiological protection, basic education, safe drinking water, etc.). In some cases such marshalling is effectively done, while in other cases, the fruits of growth are put to little use of this kind.⁷ This can make a big difference to the outcome in terms of the expansion of basic human capabilities. Similarly, while the expansion of private income certainly is of instrumental importance in enhancing basic capabilities, the effectiveness of that impact depends much on the *distribution* of the newly generated incomes. In particular, the biggest impact may be expected to occur if the rise in average GNP per head goes with a sharp reduction in the poverty of the worst-off people, rather than going in other directions. To what extent this will happen depends on a variety of economic and social circumstances related to the labor-intensive nature of techniques of production, the sharing of education and skills across the population, the success of land reforms and the sharing of rural resources, and so on. Here again the experiences of different countries and of different policy regimes have been quite divergent.

There is significant evidence that the statistical correlation between GNP per head and

human development tends to work through the impact of GNP expansion on higher public expenditure and lower poverty. For example, it is found in Anand and Ravallion (1993) that when life expectancy variations are linked with public health spending per person and an index of poverty, the addition of GNP per person as a *further* explanatory variable yields a coefficient that is not significantly different from zero.⁸ This—and related results that focus on other characteristics of quality of life—must not, of course, be interpreted to imply that economic growth does not matter in expanding the quality of life. Rather, what they indicate is that the connections are seriously *contingent*, and much depends on how the fruits of economic growth are shared (in particular what the poor get) and how far the additional resources are used to support public services (for example, public spending on health services, which are particularly crucial in influencing life expectancy).

Thus the opulence-oriented view of progress, which has little intrinsic merit (as was discussed earlier), has a conditionally important instrumental role—and that conditionality relates specifically to features on which the human development approach has tended to focus, to wit, public action and poverty reduction. There is no basic conflict between regarding economic growth to be very important, and taking it to be in itself an insufficient basis of human development. Insofar as growth of GNP or GDP promotes enhancement of living conditions, its biggest impact comes through the expanded ability to undertake public action to promote human development, and the share of the additional income that is enjoyed by the poor. In recognizing the importance of economic growth as a means for human development, we must also take full note of (i) the contingent nature of its effectiveness as means (depending on the use of the means for promoting human development), and (ii) its nonuniqueness as means (there are other means as well, including social organization).

3. THE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

(a) *The environmental challenge*

The idea of sustainable development arose essentially from concerns relating to the over-exploitation of natural and environmental

resources. Early discussions stressed the limits to economic activity imposed by the physical environment, and concluded that species and ecosystems should be utilized in ways that allow them to go on renewing themselves indefinitely (IUCN, 1980). The anxieties expressed by environmental scientists and ecologists were recognized by policymakers and economists, who attempted to formulate concepts of “sustainable development.” An early formulation by Robert Repetto (1985, p. 10) was as follows:

At the core of the idea of sustainability, then, is the concept that current decisions should not damage the prospects for maintaining or improving living standards in the future...This implies that our economic systems should be managed so that we live off the dividend of our resources, maintaining and improving the asset base so that the generations that follow will be able to live equally well or better. This principle also has much in common with the ideal concept of income that accountants seek to determine: the greatest amount that can be consumed in the current period without reducing prospects for consumption in the future.

As we shall presently argue, this connection between the ideal of sustainable development and the economic accountant’s concept of maintaining the income level (discussed, in particular, by Hicks, 1946) is an important one to explore.

A more recent characterization has been suggested by Robert Solow (1992, p. 15):

The duty imposed by sustainability is to bequeath to posterity not any particular thing—with rare exceptions such as Yosemite, for example—but rather to endow them with whatever it takes to achieve a standard of living at least as good as our own and to look after their next generation similarly. We are not to consume humanity’s capital, in the broadest sense.

In this section and the next, we follow this characterization, but we subject it to critical scrutiny in Section 3(c).

The term “sustainable development,” in fact, owes its widespread usage to the Brundtland Commission Report (WCED, 1987), *Our Common Future*, which defined it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of ‘needs,’ in particular the essential needs of the world’s poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization

on the environment's ability to meet present and future needs" (WCED, 1987, p. 43).

The Brundtland Commission definition is often cited and has become very influential.⁹ As a general statement, it reminds us that sustainability is about an obligation to future generations (toward meeting their "needs"), and thus it is necessarily about intergenerational allocation. Unlike some earlier statements, it also helpfully shifts attention away from conserving specific resources and "leaving the world as we found it" in every particular. The latter would appear to be neither feasible nor necessarily sensible: resources are basically fungible and can be substituted for one another. The Brundtland Commission's notion of sustainable development is indeed broader and invites examination even independently of environmental concerns.

Moreover, the obligation of sustainability cannot be left entirely to the market. The future is not adequately represented in the market—at least not the distant future—and there is no reason that ordinary market behavior will take care of whatever obligation we have to the future. Universalism demands that the state should serve as a trustee for the interests of future generations. Government policies such as Pigouvian taxes, subsidies, and regulation can adapt the incentive structure in ways that protect the global environment and resource base for people yet to be born. As Pigou (1932, pp. 29–30) had noted,

there is wide agreement that the State should protect the interests of the future *in some degree* against the effects of our irrational discounting and of our preference for ourselves over our descendants. The whole movement for 'conservation' in the United States is based on this conviction. It is the clear duty of Government, which is the trustee for unborn generations as well as for its present citizens, to watch over, and, if need be, by legislative enactment, to defend, the exhaustible natural resources of the country from rash and reckless spoliation.

(b) *Intergenerational equity and sustainable development*

What are our obligations to future generations? Joseph Addison, writing in *The Spectator* of 1714 was dismissive of any duty to posterity:

Most people are of the humour of an old fellow of a college, who, when he was pressed by the Society to come into something that might redound to the good of their successors, grew very peevish; 'We are always

doing,' says he, 'something for posterity, but I would fain see posterity do something for us.'¹⁰

Yet, of course, there is something posterity can do for us: it can inherit less physical and natural capital, and thus allow us to achieve—though not out of *its* choice—a higher standard of living at its expense.

How much capital *should* the future inherit from us? This has been the subject matter of optimal growth theory since the pioneering article of Frank Ramsey (1928). The theory has formed the basis of development policy and social cost-benefit analysis in the less-developed countries. In Section 5 we present a simple two-period model which captures the central features of intergenerational allocation as seen in this approach.

This framework is founded on the essentially utilitarian criterion of maximizing the sum total of welfare of different generations. It allows the welfare of one generation to be traded off one-for-one against that of another generation. If the benefit to us from economic activities which continue to emit greenhouse gases at the present rates outweighs the harm done to future generations from global warming, then the criterion would recommend no change in our activities. Other ethical notions of the total "good" may allow for different tradeoffs—for example, those that take account of welfare *inequality* between generations (see Section 5(a)). Yet others may allow no tradeoff in certain ranges—for example, those based on the "rights" of future generations to the same quality of environment and levels of clean air as the present generation has. This latter view of justice would give priority to specific rights that generations have over decisions based on a calculation of aggregate welfare (Rawls, 1971; Dworkin, 1978; Sen, 1982a,b).

Within the broadly welfarist framework of optimal growth theory—by far the main economic approach used to analyze questions of intergenerational justice—it is relevant to enquire whether sustainable development is necessarily a consequence of growth being optimal. If it were, then a (derived) justification for sustainability could be found in maximizing the total good. Let us take sustainable development to mean *nondeclining* welfare over time—although other definitions are formulated in terms of nondeclining income, consumption, or capital stock.

Even though Ramsey (1928) had argued for treating the welfare of different generations

impartially, much of the subsequent literature assumes a positive rate of pure time preference according to which well-being at a later time counts for less than well-being at an earlier time (see Section 5(b)).¹¹ Now if the social rate of return to investing in environmental capital (protection) is not large, and in particular it is smaller than the rate of pure time discount, it is not worthwhile for the present generation to reduce its consumption and increase investment: the gain in well-being to the future generation will not compensate for the sacrifice in well-being of the present generation. This can lead to a decline in well-being over time.¹² Moreover, a similar result obtains with a positive rate of pure time preference even in an economy with *exhaustible resources* (see Solow, 1974b; Dasgupta & Heal, 1979). On the other hand, universalism in the space of generational welfares—in the special form of no pure time discount—will typically lead to rising welfare over time in such models.

Yet there is no *general* presumption that sustainability will be implied by optimality in models of intertemporal allocation. It becomes an even less likely consequence once we incorporate environmental productivity and quality into production and welfare, respectively (Pezzey, 1992). Hence a justification for *sustainability* will have to be sought outside the framework of maximizing aggregate intergenerational well-being.

For Robert Solow (1974b, 1991), sustainability is simply a matter of distributional equity, about sharing the capacity for well-being between present people and future people:

[It is] an obligation to conduct ourselves so that we leave to the future the option or the capacity to be as well off as we are. It is not clear [to me] that one can be more precise than that. Sustainability is an injunction not to satisfy ourselves by impoverishing our successors. (Solow, 1991, p. 3)

The notion appears to be founded on a forward-looking application of Rawls's Difference Principle, even though Solow (1974b) recognizes the difficulties of applying this principle to the problem of saving (see Section 5(a)). Still, his concern for intergenerational equity leads him to the view that we have done rather well at the hands of *our* ancestors, who were much poorer than we are and hence might properly have saved less and consumed more. According to Solow (1991, p. 7):

You could make a good case that our ancestors, who were considerably poorer than we are, whose standard of living was considerably less than our own, were probably excessively generous in providing for us. They cut down a lot of trees, but they saved a lot and they built a lot of railroad rights-of-way. Both privately and publicly they probably did better by us than a sort of fair minded judge in thinking about the equity (whether they got their share and we got our share or whether we profited at their expense) would have required. It would have been okay for them to save a little less, to enjoy a little more and give us a little less of a start than our generation has had.

For Solow, then, sustainability would appear to be an obligation to preserve the present-day economic opportunities (such as productive capacity) for the future, not necessarily to *increase* them. This can be seen as an interpretation of the demands of “universalism” applied to intergenerational equity, and as such has much intuitive appeal.

The principle of preserving productive capacity, or society's broad “stock of capital,” can also be defended in deontological terms without a direct appeal to distributional equity. The relevant notion here is that of *usufruct rights*. We may enjoy the fruits of the accumulated capital and environmental resources that we inherit (in the form of the income and amenities to which they give rise), but we may not deplete the total stock. This principle requires us to pass on to future generations what we have inherited from past generations—since we did not accumulate or produce it ourselves. It is not based on a claim of equal well-being for the next generation.

Preserving productive capacity intact is not, however, an obligation to leave the world as we found it in every detail. What needs to be conserved are the opportunities of future generations to lead worthwhile lives. The fact of substitutability (in both production and consumption) implies that what we are obligated to leave behind is a generalized capacity to create well-being, not any particular thing or any particular resource. Since we do not know what the tastes and preferences of future generations will be, and what they will do, we can talk of sustainability only in terms of conserving a capacity to produce well-being. As Solow (1991, p. 13) again emphasizes:

Sustainability as a moral obligation is a general obligation not a specific one. It is not an obligation to preserve this or preserve that. It is an obligation, if you want to make sense out of it, to preserve the capacity to be well off, to be as well off as we. That does not

preclude preserving specific resources, if they have an independent value and no good substitutes. But we shouldn't kid ourselves, that is part of the value of specific resources. It is not a consequence of any interest in sustainability.

The idea that "income" is what can be spent while leaving the asset base intact is precisely the concept of sustainable income established by John Hicks (1946, p. 172) more than 50 years ago:

The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning. Thus, when a person saves, he plans to be better off in the future; when he lives beyond his income, he plans to be worse off. Remembering that the practical purpose of income is to serve as a guide for prudent conduct, I think it is fairly clear that this is what the central meaning must be.

It is easily seen why Repetto (1985) saw an analogy between the idea of sustainable development and the economic accountant's notion of what spendable income is.

Preservation of the resource base does not imply that all exhaustible (e.g., mineral and fossil fuel) resources must be conserved;¹³ that is likely to be unfeasible. But if society's broad stock of capital is to be maintained, we have to replace the nonrenewable resources that are used up with something else. That has to be reproducible capital, whether physical or human. The idea that the proceeds from a "wasting asset" should be set aside and reinvested so that the yield from these investments compensates for the dwindling resource is also traceable to Hicks (1946, p. 187). He argued:

If a person's receipts are derived from the exploitation of a wasting asset, liable to give out at some future date, we should say that his receipts are in excess of his income, the difference between them being reckoned as an allowance for depreciation. In this case, if he is to consume no more than his income, he must re-lend some part of his receipts; and the lower the rate of interest is, the greater the sum he will have to re-lend in order for the interest on it to make up for the expected failure of receipts from his wasting asset in the future.

It is essentially this Hicksian logic which lies behind Hartwick's (1977) rule—a rule that has

become, justly, much used in the recent environmental literature. He showed exactly how much from the use of a depletable resource should be set aside and invested in reproducible capital so that the total return (i.e. income) could be sustained over time. Hartwick's rule says that if the entire competitive rents from an economy's use of a wasting resource are invested in reproducible capital, then it will be able perpetually to maintain a constant level of consumption. The competitive rents, or pure return to the nonrenewable resource, are given by Hotelling's (1931) classic result that the shadow value of the resource rises at a rate equal to the current marginal product of reproducible capital.¹⁴ The accumulation of reproducible capital through investment of the Hotelling rents exactly offsets the (efficient) depletion of the exhaustible resource.

Although Hartwick's original rule applied to rather simple economies (with constant returns to scale, a given stock of exhaustible resources, no technical progress, and no population growth), there have been significant generalizations and elaborations of it, including the incorporation of resource amenities (see Dixit, Hammond, & Hoel, 1980).¹⁵ Solow (1986) suggests that Hartwick's rule can be given the interpretation that an appropriately defined stock of capital is being maintained intact, and that income is the interest on that patrimony. The broad notion of the stock of capital allows for exhaustible and renewable resources, for human capital, for freedom from pollution, and for other suitable forms of "environmental capital."¹⁶ Moreover, the rule has considerable intuitive appeal within the general framework of universalist ethics. It seems appropriate enough to meet our obligation to the future by channelling the rents on our use of nonrenewable resources into capital formation, any kind of capital formation—physical or human. The policy allows future generations to sustain indefinitely the income, or capacity to consume, of the present generation.

(c) *Sustaining what?*

The approach of sustainable development presupposes some basic agreement on what is to be sustained. The more specific and detailed the description of what is to be preserved, the harder in general may be the task of guaranteeing that preservation. There is, thus, the danger of *overspecification*. On the other side, if

the thing to be preserved is stated in such general terms that future generations may have legitimate reasons to grumble about their treatment by us despite the preservation of this generally specified thing, then again the approach would prove to be seriously defective. There is also, therefore, a danger of *underspecification*. The issue of finding an adequate specification of sustainable development has to face these contrary problems.

The approach that we are following in this paper is the one outlined by Solow (in the characterizations cited earlier), which concentrates on preserving some generally defined understanding of the living standard. As Solow (1991, p. 4) puts it:

If you don't eat one species of fish, you can eat another species of fish... That is extremely important because it suggests that we do not owe to the future any particular thing. There is no specific object that the goal of sustainability, the obligation of sustainability, requires us to leave untouched.

In the arguments presented in the last two sections which followed that characterization, we used functional relations that link the general notion of living standard to the means that provide the basis of such living. This approach can be criticized at two different levels: (i) in terms of the limitation of the means-end relations, and (ii) in terms of the inadequacy of the notion of overall living standard as the thing to be sustained.

The former line of criticism is easier to deal with in this paper, since the variations in the means-end relations have already been discussed in the context of the imperatives of human development, in Section 2. Sustaining a shared average income may be inadequate to provide everyone with the living standard that would have to be sustained, if the opportunities of living are to include components that do not so readily relate to the means of income. The complex basket of qualities that make up the standard of living of a person (including health, knowledge, dignity, sense of justice) may not be easy to relate to the size of capital stock in some jointly measured units, including physical and human capital.¹⁷ The causal relations that would underlie any practical application of the approach of sustainable development must take note of this complexity in the means-end relations. This is not an argument for abandoning the approach of sustainable development defined in the last two sections, but certainly a

strong reason for seeing it in more qualified terms, and for leaving the analysis open to bringing in causal relations that may not have quite the simple capital-theoretic form outlined there.

The second line of criticism raises basic difficulties of a different kind. The "claims" of the future generations may not be seen only in terms of their overall living standards. Equity may demand more specification than that. For example, the right to "fresh air" may not be seen as being so conditional that any substitution that leaves people equally well off—despite the absence of fresh air—must be taken to be, for that reason, adequate (see Sen, 1995). To consider an analogy, if a person objects to being drowned in smoke emanating from a neighbor's cigarettes, the justification of that "claim" to fresh air may be based on an argument that goes beyond equity of living standards. In particular, the possible fact that the objecting person is very much better off than the smoker—she may be richer, happier and fortunate in many other ways—need not be seen as compromising her "claim" to a smoke-free surrounding. Similarly, the future generations' claims need not be seen in entirely "substitutable" terms, even if such substitution may be adequate in an analysis of relative living standards. There is, thus, a nonwelfarist issue underlying the claims of future generations, which a welfarist conceptualization of sustainable development cannot fully capture.

This consideration may take us toward a more complex—and more contingent—view of what is to be sustained, and to that extent detach the analysis from the overarching preoccupation only with overall living standards. Again, the simple capital-theoretic formulations used in the last two sections (and in the addendum) may have to be broadened if adequate attention is to be paid to this more inclusive approach to sustainability. Such an approach would require not only that living standards in general do not fall, but also that particular entitlements (such as having reasonably fresh air, or being able to be in the sun without any immediate and terrible danger) be taken seriously. The general formula of nondeclining time profiles would, of course, apply to these more disaggregated requirements as well, but something of the simplicity of the capital-theoretic forms would be lost. This further exercise is left for a different occasion.

(d) *Intragenerational justice and human development*

We have emphasized that sustainability is a matter of *distributional equity* in a very broad sense, that is, of sharing the capacity for well-being between present people and future people in an acceptable way—that is in a way which neither the present generation nor the future generations can readily *reject*. This is a criterion of justice that has been forcefully used—though not in the context of intergenerational equity—by Thomas Scanlon (1982) and by John Rawls (1993).

There would, however, be something distinctly odd if we were deeply concerned for the well-being of the future—and as yet unborn—generations while ignoring the plight of the poor today. The moral obligation underlying sustainability is an injunction to preserve the capacity for future people to be as well off as we are. This has a terribly hollow ring if it is not accompanied by a moral obligation to protect and enhance the well-being of *present* people who are poor and deprived. If one thinks that people will be deprived in the future unless different policies are followed, then one is morally obliged to ask whether people are deprived right now. It would be a gross violation of the universalist principle if we were to be obsessed about *intergenerational* equity without at the same time seizing the problem of *intragenerational* equity: the ethic of universalism certainly demands such impartiality.

A concern for equity right now, and not merely for equity between periods of time, requires redistribution to the deprived contemporaries.¹⁸ But redistribution to poor people today might be felt to be disadvantageous from the standpoint of sustainability. It might be interpreted as leading to an increase in current consumption, not to an increase in investment. Much depends, however, on what form that redistribution takes.

This is precisely where the significance of human development as a *means* comes in (on this see the discussion in Section 4). Redistribution to the poor in the form of improving their health, education, and nutrition is not only intrinsically important—in enhancing their capabilities to lead more fulfilling lives—but it is also instrumentally important in increasing their “human capital” with lasting influence in the future. A general increase in educational levels, for example, will raise

productivity and the ability to generate higher incomes, now and in the future. The importance of maternal education in raising the quality of life and agency of later generations has also been well established (see, for example, Summers, 1992). Thus human development should be seen as a major contribution to the achievement of *sustainability*.

This argument should be contrasted with other arguments that have been proposed in the context of sustainable development. For example, poverty alleviation has been suggested as an instrument to protect the environment from degradation (World Bank, 1992). There it is argued that alleviating poverty is a prerequisite for environmental conservation:

The poor are both victims and agents of environmental damage. About half of the world's poor live in rural areas that are environmentally fragile, and they rely on natural resources over which they have little legal control. Land-hungry farmers resort to cultivating unsuitable areas—steeply sloped, erosion-prone hillsides; semiarid land where soil degradation is rapid; and tropical forests where crop yields on cleared fields frequently drop sharply after just a few years.... Poor families often lack the resources to avoid degrading their environment. The very poor, struggling at the edge of subsistence, are preoccupied with day-to-day survival. It is not that the poor have inherently short horizons; poor communities often have a strong ethic of stewardship in managing their traditional lands. But their fragile and limited resources, their often poorly defined property rights, and their limited access to credit and insurance markets prevent them from investing as much as they should in environmental protection (World Bank, 1992, p. 30).¹⁹

This argument provides an instrumental justification for poverty alleviation, as a *means* of protecting the environment. There is much substance in this. But the human development argument goes beyond that. Human development is defended as a goal in itself; it directly enhances the capability of *people* to lead worthwhile lives, so there are immediate gains in what is ultimately important, while safeguarding similar opportunities in the future. There is hardly any example in the world of the expansion of education and health being anything other than monotone: good education and good health seem to generate powerful demand for these opportunities (and more) for our children. This is a relationship that goes well beyond the redistribution of income to the poor at a given point of time—important though that is. It should also be noted that any instrumental justification for human develop-

ment is not gripped by some impersonal objective such as conserving the environment, but relates concretely to *people's* ability to generate for themselves the real opportunities of good living.

4. PUTTING SUSTAINABLE HUMAN DEVELOPMENT IN PERSPECTIVE

We end this critical account of sustainable human development with some remarks on the relationship between ends and means. The basic rationale of the human development approach, as we have discussed, lies in the fact that the constitutive elements of human development are closer to the shared human ends than are some of the more commonly-used criteria of progress, such as the growth of GNP per person. In contrast, the importance of GNP growth and related achievements in expanding the means of life lies in their instrumental relevance. This thesis—based on the significance of human development as an end—should not, however, be construed as a denial of the importance of human development as a means as well. Human development, in the form of people being better educated, more healthy, less debilitated, and so on, is not only constitutive of a better quality of life, but it also contributes to a person's productivity and her ability to make a larger contribution to the progress of material prosperity.

Indeed, recent works on economic growth have demonstrated the far-reaching role of education, health, and other human qualities in generating economic growth. For example, in interpreting the causal antecedents of the so-called "East Asian miracle," it has increasingly become clear that a foundational and immensely far-reaching role has been played by the enhancement of the quality and skill of labor.²⁰ This is, in fact, the "human capital" aspect of human development. The economic roles of better and more widespread schooling, good health and nourishment, learning by doing, and technical progress all point to the importance of human agency as a prime mover of material progress. There are many lessons to be learned from these experiences, and the powerful instrumental role of human development—in addition to its intrinsic importance—is certainly quite central to our understanding of the economic and social world.

The human development approach must take full note of the robust role of human capital,

while at the same time retaining clarity about what the ends and means respectively are. What has to be avoided is seeing human beings as merely the means of production and material prosperity, taking the latter to be the end of the causal analysis—a strange inversion of objects and instruments. That is the danger to which an approach that sees women and men only as "human capital" is open. Rejecting such exclusive concentration on people as "human capital" is central to the human development approach. But that disputation does not, in any way, deny the commanding role of human capital in enhancing production and material prosperity as well.

Rather, we have to see human development as having both *direct* and *indirect* importance. Since education, health, and quality of life have intrinsic value, human development has direct—and immediate—importance. In addition, since the quality of human agency is enhanced by better education, health, etc., it is also the case that human development has great indirect importance. The material prosperity that is advanced by human development can, in its turn, contribute to further increases in the quality of human life. The importance of this indirect connection adds to the relevance of human development, but does not detract from its direct importance. The human development approach includes the significance of human capital without making that perspective supplant the view of human beings as the end of the exercise, rather than as means of production and of economic activity.

Immanuel Kant's injunction "to treat humanity" ultimately "as an end withal, never as means only" remains just as powerful, even when the great importance of human capital in economic growth is appropriately acknowledged. Needless to say, this applies to our obligations to the future generations as well. The importance of human capital indicates that the pivotal role of education, health, training, etc., in work and production must be kept firmly in view in considering alternative scenarios of sustainable development; human skill and agency would be important not just in raising productivity, but also in devising ways and means of dealing with environmental and other challenges. But, while taking full note of this instrumental importance of human quality in maintaining and expanding the material basis of human life, we must not lose sight of the central importance of the quality of human life as an end in itself. What is to be sustained is

the nature of the lives that people can lead, and the fact that in that sustaining, human agency would be pivotal, does not reduce in any way the significance of human life as an end.

The discipline of universalism requires us to extend the same concern for all human beings—irrespective of race, class, gender, nationality, or generation. The underlying ethics of it sees different human beings as important in the same way. This importance relates to the personhood of people: human beings seen as persons—not as means of production. As a matter of fact, human beings are also superb means of production. But that is not the most momentous fact about us.

The overarching relevance of sustainable human development lies in that basic recognition. In extending the concern for human development from the present generation to those in the future, the conceptual issues that are raised have corresponding atemporal analogues. The approach pursued in this paper has tried to draw on that basic similarity between the claims of the present and those of the future generations. The linkage of the two has been analyzed in terms of the broad notion of sustainability, integrating the concerns of the present and the future. While many foundational problems remain to be further addressed (we have specifically identified some of them), it is particularly important to place the concern about equity in the contemporary world and equity in the future in a generally integrated framework. This paper has been aimed as a small contribution to that large task of integration.

5. ADDENDUM: OPTIMALITY, SUSTAINABILITY, AND PURE TIME PREFERENCE

In this addendum we explore the relationship between optimal development and sustainable development with a view to clarifying the extent to which they are congruent and how they might conflict. For this exercise we use the “welfarist” framework developed in Sections 3(a) and 3(b), some of the limitations of which are discussed in Section 3(c). Even in a more general nonwelfarist framework, elements of conflict and congruence would occur in similar ways.

A simple two-period model is presented to examine the central ideas; it is general enough for the points we wish to make. The purpose is

not to present a full-blown optimizing model which incorporates capital of different types (physical, natural, etc.) into production, and environmental amenities, pollution, etc. into the utility or well-being function; there are many such models available in the literature (for example, see Dorfman, 1997; Pearce & Warford, 1993; and the references cited there). Rather, our purpose is a *conceptual* one: to ask whether in the simplest possible optimizing model, sustainability is implied by optimality. If it is *not*, then by introducing environmental externalities and nonrenewable resources into the model, sustainability will be an even less likely consequence of optimality. In other words, we will have to look elsewhere for an ethical justification of sustainability. It will also follow that intertemporal optimization models which incorporate environmental variables are not necessarily models of sustainable development. Conceptually, then, a different type of model from those usually adopted for planning purposes in developing countries will be required. It is important to recognize this significant departure from standard practice if there is an intrinsic concern with sustainability.

This addendum can in some ways be seen as a response to the challenge in Pearce and Warford (1993, p. 36): “...insofar as past development policy has been influenced by the theory of optimal growth—and it clearly has—there is a critical need to analyze the conditions under which optimal growth is also sustainable growth.”

(a) *Concepts of optimality and sustainability*

The now standard economic literature on optimal growth goes back to the classic article of Ramsey (1928) entitled “A Mathematical Theory of Saving.” In it, Ramsey solved the problem of maximizing the sum total of utility (or welfare) over an infinite time horizon subject to a given technology and initial capital stock. Ramsey’s seminal paper has spawned a vast literature in the 1960s; this is reviewed by Koopmans (1967a,b, 1977). Most of this literature adopts as the objective to be maximized—the optimality criterion—an integral over time of the discounted utility flow $e^{-\rho t} u(c_t)$, where c_t is consumption at time t , $u(c)$ is an increasing and strictly concave function, and $\rho > 0$ is the rate of pure time discount. Thus the optimality criterion is generally taken to be the maximization of

$$\int_0^\infty e^{-\rho t} u(c_t) dt$$

subject to given assumptions about the aggregate production function, population growth, and technological progress.

This optimal economic growth framework allows us to examine many of the questions involving sustainable development. We can, for example, talk of “sustaining” consumption c_t , income or output q_t , capital stock k_t , or well-being ω_t —which is broader than utility u_t .²¹ Does intertemporal optimization imply that each of these variables will be nondeclining over time? If not, optimality and sustainability may be in conflict. How might one justify a concern with sustainability in this case? Would a greater concern for intergenerational equity in the optimality criterion lead to the stock of capital k_t or level of welfare ω_t being maintained over time? How do the rate of time preference and technical progress, respectively, affect the sustainability of each of the variables considered? Under what assumptions, if any, can sustainability be derived as a consequence of optimization?

The relationship between sustainability and optimality of a path of development can be illustrated by means of a simple discrete two-period model. Many of the questions posed above can be answered in the context of such a model, without any loss of generality. Moreover, the reasons for the outcomes can be explained just as effectively as in a full-blown infinite time horizon model.

We assume there are just two periods, indexed by 0 and 1, and only one good (“corn”), which can be either consumed or invested. An amount k_0 of the good (the initial “capital stock”) is available for consumption c_0 or investment ($k_0 - c_0$) in period 0. The production function is $q = f(k)$, which is increasing and strictly concave in capital k (i.e. displays positive and diminishing marginal product). Since there is no future beyond period 1, we assume that all output is consumed in period 1, i.e. $c_1 = f(k_0 - c_0)$.²² Our two-period allocation problem is then to maximize the present discounted value of well-being

$$\omega(c_0) + \frac{1}{1 + \rho} \omega(c_1)$$

subject to the constraint that

$$c_1 = f(k_0 - c_0).$$

Substituting the constraint into the objective function reduces the problem to choosing c_0 to maximize

$$\omega(c_0) + \frac{1}{1 + \rho} \omega(f(k_0 - c_0)).$$

This yields the first-order condition

$$\omega'(c_0) = \frac{1}{1 + \rho} \omega'(c_1) \cdot f'(k_0 - c_0)$$

or

$$\frac{\omega'(c_0)}{\omega'(c_1)} = \frac{1 + \text{MPK}}{1 + \rho},$$

where MPK is the marginal product or “return” per unit of capital net of the amount invested.

The standard marginalist reasoning can be invoked to justify the first-order condition. The loss in present discounted well-being from consuming one unit less in period 0 is $\omega'(c_0)$. The gain in output next period is $(1 + \text{MPK})$, which is valued at $\omega'(c_1)$, implying a gain in well-being in period 1 of $\omega'(c_1)(1 + \text{MPK})$. But well-being in period 1 is worth only $1/(1 + \rho)$ in terms of well-being in period 0. Hence the gain in present discounted well-being is

$$\omega'(c_1)(1 + \text{MPK})/(1 + \rho).$$

At the optimum, the loss in the objective function (present discounted well-being) from consuming one unit less in period 0 must equal the gain. Hence the above first-order condition.

We can now ask whether the optimum solution to this intertemporal problem implies *nondeclining* consumption and well-being. From the optimality condition, it follows that

$$\omega'(c_0) \geq \omega'(c_1)$$

according as

$$\text{MPK} \geq \rho.$$

Hence if the marginal product of capital is greater than ρ , then $\omega'(c_0)$ will be greater than $\omega'(c_1)$, and c_0 will be less than c_1 because of strict concavity of the function $\omega(c)$. In this case, sustainability (i.e. rising c_t and ω_t) follows as a consequence of optimization. In particular, if $\rho = 0$ and the technology is productive ($\text{MPK} > 0$), consumption and well-being will rise over time.

What if the technology is not as productive as ρ , the rate of pure time discount? If MPK is smaller than ρ , then $\omega'(c_0)$ will be less than

$\omega'(c_1)$, and c_0 will be *greater* than c_1 (by concavity). In this case, consumption c_t and well-being $\omega(c_t)$ will *fall* over time, and the optimum path will not be sustainable. Thus sustainability is not necessarily implied by optimality. Indeed the higher is the rate of pure time discount ρ , the less likely it is that the optimal path will be sustainable. The example also demonstrates that requiring a path of consumption to be sustainable can be at the expense of achieving the maximum present discounted value of well-being.

This simple two-period model serves to illustrate that optimality and sustainability are logically distinct criteria of development. One cannot be deduced from the other as a necessary consequence. It may, however, be objected that the model is overly simple: it does not take account of technical progress, population growth, or an intrinsic concern for equity between generations. We examine these features in turn by extending the model while retaining its two-period assumption.

Technical progress is readily incorporated into the model by assuming that the productivity of capital rises exogenously at the rate of λ per period. This implies that consumption in period 1 will be $c_1 = (1 + \lambda)f(k_0 - c_0)$, and the new first-order condition will be

$$\frac{\omega'(c_0)}{\omega'(c_1)} = \frac{(1 + \lambda)(1 + \text{MPK})}{(1 + \rho)}.$$

For sustainability we require $\omega(c_0) < \omega(c_1)$, or $\omega'(c_0) > \omega'(c_1)$ given strict concavity of the well-being function $\omega(c)$. Thus sustainability requires that $(1 + \lambda)(1 + \text{MPK}) > (1 + \rho)$, and this condition is more likely to be fulfilled the higher is the rate of technical progress λ (and the lower is the rate of pure time discount ρ). Intuitively, the gain from consuming one unit less in period 0 is now higher at

$$(1 + \lambda)(1 + \text{MPK}),$$

rather than simply $(1 + \text{MPK})$, times $\omega'(c_1)$. Hence consuming less today relative to tomorrow will yield a higher present discounted value of welfare; this makes it more likely that consumption and well-being will *rise* over time.^{23,24}

Population growth can also be incorporated into the basic model. But we now have to consider two different forms of the welfare function, corresponding respectively to the “average” and “total” forms. In the average form, we simply maximize the present discoun-

ted value of *average* well-being over time. If the rate of population growth is n per period, then average consumption in period 1 will be

$$c_1 = \frac{f(k_0 - c_0)}{1 + n}$$

because the total output in period 1, $f(k_0 - c_0)$, must now be shared by $(1 + n)$ times as many people as in period 0. The discounted value of average well-being is

$$\omega(c_0) + \frac{1}{(1 + \rho)}\omega(c_1),$$

where c_0 and c_1 are average consumption in periods 0 and 1, respectively. The first-order condition for this case is

$$\frac{\omega'(c_0)}{\omega'(c_1)} = \frac{(1 + \text{MPK})}{(1 + \rho)(1 + n)}.$$

Sustainability requires $c_0 < c_1$ or $\omega'(c_0) > \omega'(c_1)$, which implies

$$(1 + \text{MPK}) > (1 + \rho)(1 + n).$$

The condition for sustainability is thus more stringent compared with the no population growth ($n = 0$) situation, making it less likely to be achieved.

The “average” criterion can, however, be criticized on a number of grounds (Parfit, 1984; Broome, 1992; *inter alia*). The criterion of “total well-being” weights average well-being in each period by the number of people, so that the welfare function (present discounted value of total well-being) becomes

$$\omega(c_0) + \frac{(1 + n)\omega(c_1)}{(1 + \rho)},$$

where c_0 and c_1 are average consumption in periods 0 and 1, respectively. In this case, the first-order condition reduces to the earlier zero population growth condition

$$\frac{\omega'(c_0)}{\omega'(c_1)} = \frac{1 + \text{MPK}}{1 + \rho},$$

and implies the same condition for sustainability as before, *viz.* $\text{MPK} > \rho$. The reason is that although the gain in output from a unit sacrifice in consumption in period 0 is shared by $(1 + n)$ more people in period 1, and is therefore only $1/(1 + n)$ times its former size per person, there are now $(1 + n)$ times as many people enjoying this gain in average consumption. These two factors exactly balance out to give the same first-order condition as in the no population growth case.

We can also incorporate a concern for equity between generations into the model. The welfare function thus far has been the sum total of discounted well-being over time. Discounting implies placing less weight on the well-being of future generations, not because they are better off—but because their well-being happens to arise later. But we might also wish to place less weight on the well-being of generations that are better off. In other words, the welfare function should reflect that a unit increase in well-being to a worse-off generation counts for more than a similar increase to a better-off generation. The simplest way of allowing for both pure time discount and well-being inequality between generations is to take a (quasi-) concave transformation of the well-being values that are comparable over time, *viz.* $\omega(c_0)$ and $\omega(c_1)/(1 + \rho)$. A form which is separable and isoelastic in these numbers is

$$\frac{1}{1 - \varepsilon} [\omega(c_0)^{1-\varepsilon} + (\omega(c_1)/(1 + \rho))^{1-\varepsilon}]$$

for $\varepsilon \geq 0, \varepsilon \neq 1$

and

$$\log[\omega(c_0)] + \log[\omega(c_1)/(1 + \rho)] \quad \text{for } \varepsilon = 1.$$

Such a welfare function reduces to the sum total of discounted well-being when $\varepsilon = 0$; and it tends to the Rawlsian function

$$\text{Min}\{\omega(c_0), \omega(c_1)/(1 + \rho)\}$$

when ε tends to ∞ .²⁵ For $\varepsilon > 0$ it embodies a concern for inequality in the discounted well-being of different generations. The parameter ε is a measure of aversion to inequality in levels of “comparable” well-being across generations.

Substituting $c_1 = f(k_0 - c_0)$ into this welfare function, and maximizing it with respect to c_0 yields the first-order condition

$$\frac{\omega'(c_0)/\omega(c_0)^\varepsilon}{\omega'(c_1)/[\omega(c_1)/(1 + \rho)]^\varepsilon} = \frac{1 + \text{MPK}}{1 + \rho}.$$

Now the function $\omega'(c)/\omega(c)^\varepsilon$ is decreasing in c for $\varepsilon \geq 0$. Hence the condition for sustainability in this case is

$$(1 + \text{MPK}) > (1 + \rho)^{1-\varepsilon}.$$

This is more likely to be satisfied the larger is ε , *ceteris paribus*. Moreover, if $\varepsilon \geq 1$, the condition is assured with a positive MPK. As ε tends to infinity, the optimum solution tends to equality of $\omega(c_0)$ and $\omega(c_1)/(1 + \rho)$. For $\rho > 0$, this of course implies that $\omega(c_1) > \omega(c_0)$ or, in other words, $c_1 > c_0$.²⁶ But if $\rho = 0$, then the

Rawlsian solution is equality of $\omega(c_0)$ and $\omega(c_1)$, i.e. consumption is constant over time.

A rigid egalitarianism is implied in Rawls’ Difference Principle, interpreted by economists as the Maximin Rule in the space of utilities. In discussing the application of this rule in an intertemporal context, we shall henceforth take ρ to be 0, and will attempt to justify this assumption later. Although Rawls objects to utilitarianism applied between generations on the grounds that it will demand too much sacrifice by some generations for the sake of a greater gain by other (richer) ones, he is reluctant to apply his Difference Principle between generations. Thus, on the problem of optimum savings, Rawls (1971, pp. 284–293) states:

...the question of justice between generations...subjects any ethical theory to severe if not impossible tests...I believe that it is not possible, at present anyway, to define precise limits on what the rate of savings should be. How the burden of capital accumulation and of raising the standard of civilization is to be shared between generations seems to admit of no definite answer. It does not follow, however, that certain bounds which impose significant ethical constraints cannot be formulated...Thus it seems evident, for example, that the classical principle of utility leads in the wrong direction for questions of justice between generations...Thus the utilitarian doctrine may direct us to demand heavy sacrifices of the poorer generations for the sake of greater advantages for later ones that are far better off. But this calculus of advantages which balances the losses of some against benefits to others appears even less justified in the case of generations than among contemporaries...It is a natural fact that generations are spread out in time and actual exchanges can take place between them in only one direction. We can do something for posterity but it can do nothing for us. This situation is unalterable, and so the question of justice does not arise...It is now clear why the (max–min criterion) does not apply to the savings problem. There is no way for the later generation to improve the situation of the least fortunate first generation. The principle is inapplicable and it would seem to imply, if anything, that there be no saving at all. Thus, the problem of saving must be treated in another fashion.

In one of the earliest contributions to the economic literature on intergenerational equity (in the presence of exhaustible resources), Solow (1974b) explores the implications of adopting the Maximin Rule—even though he concedes he is being “plus Rawlsien que le Rawls.” The solution is as obtained in the above two-period model with ρ set at 0 and ε made indefinitely large. Consumption and the standard of living will be constant over time: it

is not desirable for any generation to sacrifice consumption for the sake of greater consumption by a better-off generation.²⁷ The problem with this solution, as hinted above by Rawls himself, is that it is too much at the mercy of the initial conditions. If the initial capital stock k_0 is small, then no more will be accumulated, and the standard of living will be low forever. As Solow (1986, p. 144) put it, “a society starting out poor would find no justification for the initial accumulation that could provide a higher standard of consumption in the future.”

Considerations of this sort suggest a constraint on the floor level of consumption or well-being. Apart from the criteria of optimality and sustainability (the latter being a constraint on the time derivative of consumption or well-being), we can incorporate a constraint in terms of a minimum desirable standard of living. This can be specified as a lower bound on the level of consumption, \underline{c} , or of well-being, $\underline{\omega}$, or of output, \underline{q} , at all times. It can be justified in terms of notions of “basic needs” fulfillment or “subsistence” which also underlie the Brundtland Commission Report (meeting the needs of the present without compromising the ability of future generations to meet their own needs).

There are three distinct criteria we have discussed in relation to intertemporal allocation: optimality, sustainability, and a minimum standard of living. They are characterized in Table 1 (Pezzey, 1992).

We have seen in the context of the two-period model that a path of development can be optimal but not sustainable, and can be sustainable but not optimal. Moreover, it is possible to set the minimum standard of living constraint at a level which violates either or both of optimality and sustainability. In other words, the three criteria of development are logically independent: all three, any two, just one, or none, may be satisfied. It follows, in particular, that the concept of sustainability cannot be derived from either of the other two criteria.

Table 1. *Criteria for intertemporal allocation*

Criterion	Characterization
Optimality	Maximize $\int_0^\infty e^{-\rho t} \omega(c_t) dt$
Sustainability	$\dot{c}_t \geq 0, \dot{\omega}_t \geq 0, \dot{k}_t \geq 0,$ $\dot{q}_t \geq 0$ for all t
Minimum standard of living	$c_t \geq \underline{c}, \omega_t \geq \underline{\omega}, q_t \geq \underline{q}$ for all t

(b) *The rate of pure time preference*

One of the main reasons why sustainability does not follow from intertemporal optimization (in the broadly welfarist framework of the two-period model above) is that future generations’ well-being is discounted at a positive rate.²⁸ What is the justification for such an assumption? Ramsey (1928, p. 543) had himself “...assumed that we do not discount later enjoyments in comparison with earlier ones, a practice which is ethically indefensible and arises merely from the weakness of the imagination.” Pigou (1932, pp. 24–25) felt that although “everybody prefers present pleasures or satisfactions of given magnitude to future pleasures or satisfactions of equal magnitude, even when the latter are perfectly certain to occur,” “...this preference for present pleasures...implies only that our telescopic faculty is defective.”

Harrod (1948, pp. 37–40) went even further, and suggested that:

Time preference in this sense is a human infirmity, probably stronger in primitive than in civilized man... On the assumption...that a government is capable of planning what is best for its subjects, it will pay no attention to pure time preference, a polite expression for rapacity and the conquest of reason by passion.

Finally, Solow (1974a, p. 9) argues that:

In social decision-making, however, there is no excuse for treating generations unequally, and the time-horizon is, or should be, very long. In solemn conclave assembled, so to speak, we ought to act as if the social rate of time preference were zero (though we would simultaneously discount future *consumption* if we expect the future to be richer than the present). I confess I find that reasoning persuasive, and it provides another reason for expecting that the market will exhaust resources too fast.

These are arguments about impartiality with respect to time: well-being at one point in time should not count for more than well-being at another. They do not affect the case for discounting future *consumption* if consumption is expected to grow over time. The consumption discount rate reflects both the higher level of consumption in the future and the decrease in the marginal *value* of consumption: it is simply the growth rate of consumption per capita times the elasticity of the marginal well-being function. The marginal well-being function $\omega'(c)$ represents a distributional weighting system between generations attaining different

levels of consumption.²⁹ The weights $\omega'(c)$ ignore the time at which a generation lives.

Assuming a pure time preference rate of $\rho = 0$ (applied to well-being) raises a technical problem for the intertemporal optimality criterion

$$\int_0^\infty e^{-\rho t} \omega(c_t) dt.$$

Without a positive discount factor ($\rho > 0$), this integral will not converge over an infinite horizon for all paths of interest.³⁰ Ramsey (1928) got around this difficulty through his ingenious device of a “bliss” level of consumption \hat{c} at which, in his formulation, marginal utility falls to zero. Instead of maximizing the above integral, Ramsey minimized the integral of the excess of bliss utility over attained utility:

$$\int_0^\infty [u(\hat{c}) - u(c_t)] dt.$$

This is equivalent to maximizing

$$\int_0^\infty [u(c_t) - u(\hat{c})] dt.$$

A modern variant of Ramsey’s device, which serves the same purpose, is the so-called overtaking criterion proposed by von Weizsäcker (1965). This criterion achieves comparisons of consumption paths over an infinite future while comparing integrals over finite horizons only. A path c_t is declared better than an alternative path c'_t if there exists a time T' such that

$$\int_0^T \omega(c_t) dt > \int_0^T \omega(c'_t) dt \quad \text{for all } T \geq T'.$$

From time T' onward, the (finite) utility integral for path c_t has overtaken that for path c'_t .³¹ Although the overtaking criterion does not choose between every possible pair of paths, the partial ordering defined by it suffices to determine a unique optimal path in the circumstances assumed by Ramsey.

The circumstances assumed by Ramsey were no population growth and a constant technology. Koopmans (1965, p. 239) also admits to “an ethical preference for neutrality as between

the welfare of different generations,” and generalizes Ramsey’s results to a situation of exponential population growth and technical progress. The device he uses is not Ramsey’s bliss level of consumption, but a different asymptote from which he subtracts attained utility. This is the so-called *Golden Rule* level of consumption (Phelps, 1966), defined as the maximum level of consumption (and utility) per head that can be maintained indefinitely. Note that the Golden Rule of accumulation is a concept of sustainability, but at a level that achieves the highest constant consumption per head over time. Phelps (1966, p. 5) christened it a golden rule because then “...each generation saves (for future generations) that fraction of income which it would have past generations save for it.”

We can incorporate a concern for equity between generations into the overtaking criterion in much the same way as before. Instead of taking the integral (i.e. sum total) of well-being over time, we can take the integral of a concave (isoelastic) transform of the numbers ω_t . Thus in the criterion, we simply substitute $\omega(c)^{1-\varepsilon} / (1 - \varepsilon)$ for $\omega(c)$, where $\varepsilon \geq 0$ (and $\varepsilon \neq 1$).

An alternative approach to equity between generations has been suggested by Asheim (1993). Essentially, he proposes a combination of the overtaking criterion and generalized Lorenz dominance in the space of “quality of life,” i.e., well-being. He defines a path c_t to be as “just” as an alternative path c'_t if there exists a T' such that for all $T \geq T'$

$$\int_0^T \omega(c_t) dt \geq \int_0^T \omega(c'_t) dt$$

and $\{\omega(c_t) | t \in [0, T]\}$ Lorenz dominates $\{\omega(c'_t) | t \in [0, T]\}$.

This criterion of justice requires $\omega(c_t)$ both to catch up with $\omega(c'_t)$ in finite time and to be as egalitarian in the Lorenz sense. Thus preferred paths are those that both increase the total sum to be shared between generations and share it in a more egalitarian way. In a productive technology, this leads to the result that a path is just if and only if it is dynamically efficient and nondecreasing (i.e., sustainable).

NOTES

1. The basic approach goes back to earlier works of Aristotle (*Nicomachean Ethics* and *Politics*), Adam Smith (*Theory of Moral Sentiments* and *Wealth of*

Nations), and others. In the modern literature, this approach has been pursued and developed in Sen (1980, 1985a,b, 1987), Drèze and Sen (1989), Griffin and

Knight (1989), Desai (1991), Anand (1994), and Haq (1995).

2. While neither Paine (1792) nor Wollstonecraft (1792) were particularly concerned with future generations, in addition to the present, the universalist approach underlying their justificatory arguments can be readily extended to the future generations as well. On this general interconnection, see Rawls (1971).

3. See Sen (1988).

4. On the constitutive and causal aspects of "living standards" and "the quality of life," see Sen (1987, 1993).

5. For critiques of GNP-based judgements and explorations of alternatives, see Streeten, Burki, Haq, Hicks, and Stewart (1981), Streeten (1984), Stewart (1985), Desai (1991), Griffin and Knight (1989), Desai, Boltvinnik, and Sen (1991), and Anand and Ravallion (1993), among other contributions.

6. See Anand (1991). See also Anand and Ravallion (1993), where an R^2 of 0.45 is obtained in regressing the logarithm of shortfall of life expectancy (from a postulated maximum of 80 years) against the logarithm of GNP per person. The exact fitted equation is, in fact:

$$-\log(80 - L) = -\underset{(2.07)}{6.15} + \underset{(4.00)}{0.45} \log(Y), \text{ with } R^2 = 0.45,$$
 where L is the life expectancy at birth in years, and Y is GNP per person (in PPP\$).

7. The distinction corresponds to what Drèze and Sen (1989) have called "growth-mediated security" and "unaided opulence;" there are many empirical examples of each.

8. More exactly, the statistical fit obtained by Anand and Ravallion, based on comparable data for 22 developing countries for which the relevant statistics were available, is:

$$-\log(80 - L) = -\underset{(2.34)}{1.08} - \underset{(1.34)}{0.28} \log(Y) - \underset{(2.36)}{0.21} \log(P) + \underset{(3.02)}{0.30} \log(H),$$

with $R^2 = 0.71$, where L stands for life expectancy in years, Y for GNP per person (in PPP\$), P for the proportion of people in poverty (consuming less than PPP\$1 per day in 1985), and H for public spending on health per person. For more detailed explanations and related results, see Anand and Ravallion (1993).

9. For example, it is strongly endorsed in World Bank (1992, Box 2, p. 8).

10. *The Spectator*, Vol. VIII, No. 583, August 20, 1714.

11. As Sidgwick (1907, p. 414) had argued, this is incompatible with universalism within the context of utilitarianism: "It seems...clear that the time at which a man exists cannot affect the value of his happiness from a universal point of view; and that the interests of posterity must concern a Utilitarian as much as those of his contemporaries, except in so far as the effect of his actions on posterity—and even the existence of human beings to be affected—must necessarily be more uncertain."

12. Section 5(a) discusses extensions of this result to situations involving technical progress, population growth, and a concern for well-being equality between generations.

13. See, however, Pearce, Barbier, and Markandya (1988, p. 6).

14. See Anand and Nalebuff (1987) for further discussion of Hotelling's rule.

15. See also Hammond (1993), Hartwick (1978), Solow (1986), Ahmad, El Serafy, and Lutz (1989), El Serafy (1991), Lutz (1993), Bartelmus (1993) among others.

16. What is maintained constant in Hartwick's rule is a chain (or Divisia) index of the combined value of resource and capital stocks.

17. On this general question, see Dorfman (1997).

18. There are few models of intertemporal allocation which incorporate a concern for distribution among contemporaries. Anand and Joshi (1979) present one, and derive the optimum solution for extreme values of the "aversion" to well-being inequality—both inter *and* intragenerational. With no pure time discount, as this inequality aversion parameter tends to infinity, the entire surplus from production is redistributed to the poor of today, and there is no capital accumulation. This is like the Rawlsian solution derived by Solow (1974b).

19. This view of the poverty-environment nexus is also prominent in Mink (1993) and Pearce and Warford (1993). See also Repetto (1987).

20. See particularly World Bank (1993), and the extensive literature cited there. See also Birdsall's (1993) forceful exposition of the accumulated evidence in favor of the view that "social development is economic development." For a classic contribution to the importance of education as a prime mover of progress, see Schultz (1980).

21. With $\omega(\cdot)$ an increasing function solely of consumption c_t , sustaining ω_t and sustaining c will be equivalent. But our well-being function $\omega(\cdot)$ can also depend on pollution, environmental amenities, etc., so that sustaining c_t and sustaining ω_t could in general be different.
22. In this or any finite time horizon model, we cannot solve for the optimal capital stock to bequeath to the future since the welfare of future generations (beyond the time horizon of the model) does enter into the model. Finite time horizon models arbitrarily specify a terminal capital stock, which in our case we specify as 0.
23. It does not, however, follow that the capital stock k_t is also more likely to rise over time. The same amount of physical capital is now more productive over time and less of it is required to produce any given level of output.
24. Solow (1992, p. 15) points out that: "Sustainability is not always compatible with discounting the well-being of future generations if there is no continuing technological progress. But I will slide over this potential contradiction because discount rates should be small and, after all, there is technological progress."
25. With pure time discount ρ , the Rawlsian welfare function corresponds to maximizing the smallest value of $\omega_t/(1+\rho)^t$ for $t = 0, 1, 2, \dots$.
26. Note that sustainability has been made more likely here by specifying a concern for inequality in *discounted* well-being rather than in the actual level of well-being of different generations. In the extreme (the Rawlsian case), this leads to equality of discounted well-being, which (with a positive pure time preference rate) implies a rising level of well-being over time.
27. In a multiperiod model, this implies zero net saving with a stationary technology, and *negative* net saving with advancing technology ($\lambda > 0$). In this case, the capital stock k_t will *decline* over time.
28. Pigou (1932, p. 25) felt such discounting revealed "...a far-reaching economic disharmony. For it implies that people distribute their resources between the present, the near future and the remote future on the basis of a wholly irrational preference. When they have a choice between two satisfactions, they will not necessarily choose the larger of the two, but will often devote themselves to producing or obtaining a small one now in preference to a much larger one some years hence. The inevitable result is that efforts directed towards the remote future are starved relatively to those directed to the near future, while these in turn are starved relatively to efforts directed towards the present."
29. Distribution problems between individuals living at the same time are ignored by assuming there is *equal* distribution among contemporaries. See, however, Anand (1981) and Anand and Joshi (1979), where distribution both among contemporaries and over time are incorporated in a dynamic model.
30. For some authors this appears to be a sufficient reason for assuming a positive pure time preference rate. This is, however, more a matter of convenience than of reflection.
31. When the discount rate ρ is positive, the overtaking criterion is equivalent to the maximization of discounted utility over infinite time.

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