Our theories ... are rays of light, which illuminate a part of the target, leaving the rest in darkness ... It is obvious that a theory which is to perform this function satisfactorily must be well chosen; otherwise it will illumine the wrong things. Further, since it is a changing world that we are studying, a theory which illumines the right things at one time may illumine the wrong things at another.


Introduction

In Western and westernized societies, the primary promulgators of values, knowledge, and collective action are separate institutions. However, linkages among church, science, and the state are necessary in spite of the principle of separation. How could governmental agencies unable to return to their governing bodies on every decision, determine what should be done without appealing to values, and, apart from science, ascertain how best to do it? For questions of economic development, such linkages were effectively made through the first half of the 20th century by progressive technocrats, engineers, agricultural scientists, foresters, and, later, professional planners. The public sanctioned these professionals to act—to combine publicly held values with scientific knowledge—on its behalf. This sanctioning was rooted in a common vision of progress and a shared faith in how Western science and technology could accelerate development.1

1 I use the term “progressive technocrat” in the sense formalized by the thinking of Auguste Comte (A General View of Positivism, 1848) and as implemented in Western countries beginning with the progressive era at the last turn of the century. The term incorporates the general belief that much of the “subjective” folly of politics can be avoided by the use of technical experts who provide “objective” knowledge with respect to what can be done and then implement legislative decisions effectively, rationally following established rules or scientific laws. For an interpretation of the evolution of progressive thinking in economics as a material, earth-bound, extension of Judeo-Christian progressive beliefs, see Nelson (1991).

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Economists, with their more encompassing definition of efficiency and explicit belief in positivism, helped fill the void after World War II. Economists rapidly assumed positions in the machinery of government in democratic and authoritarian, and capitalist and socialist states alike. During this same period, economists’ progressive optimism for the possibilities of material plenty for all the people of the world also carried them, naively for sure, to the head of the global pursuit for economic development. A repertoire of practical economic experience and understanding as well as arguments developed to justify practice rapidly accumulated. The international discourse on the sustainability of development challenges these understandings and beliefs accumulated since World War II.

The style of international economic development that actually unfolded was a product of myriad factors in different places, but economists assumed the burden of trying to guide, explain, and rationalize the development process. Their representations were soon challenged, however, by others, typically with natural science training, who interpreted the development process quite differently. In the late 1960s and early 1970s, scientists concerned with population growth (Ehrlich 1968; Ehrlich and Ehrlich 1990) and resource (Meadows 1972) scarcity argued that the number of people could not keep doubling and that the course of development, for rich and poor nations alike, had to become more resource-conserving. Although these interpretations incorporated technological change, they did not optimistically assume that endogenously generated technological change would automatically be sufficient to resolve whatever problem might arise.

As the decade of the 1970s progressed, problems in environmental management were beginning to become obvious to more and more people. Technologies initiated for developing nations conflicted with understandings recently acquired in the industrialized nations. Green revolution technologies, for example, with their greater dependence on fertilizers and pesticides, were being adopted in developing countries at the same time that concerns over energy scarcity and the misuse of toxics in developed nations were rising. At about the time that new technologies finally seemed to be propelling Third World development, people in the industrialized North realized that new technologies can be expected to have unforeseeable, undesirable consequences. And the unforeseen and undesired that appeared in the South seemed especially so.

In other cases, development seemed to be propelled along an environmentally and culturally destructive course because of a multitude of interactive causes within and between poor and rich nations. The causes of deforestation in the tropics, for example, have been both very complex and specific to different locations and time periods. Even though instigated by a confluence of different

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2 For reflections on the rise of economists in governments throughout the world, including in international development agencies, see Pechman (1989).
interactive causes in different places, the rise in deforestation rates matched a
growing public awareness in industrialized nations of the importance of
biodiversity. Similarly, the rise in conflicts with tribal peoples coincided with a
rising interest in the cultural survival of the few traditional peoples still on the
globe.

It is important to keep in mind that both the dominant vision of what
development could be, commonly attributed to economists, and the stance of its
critics, customarily thought of as environmentalists, are broadly based and rather
amorphous. The historic roots of each intertwine with Western traditions,
religion, philosophy, and science, and with the experience of developed nations.
Recently, each has also acquired new roots springing from the traditions and
experience of the cultures and environments of developing nations. Neither
economic nor environmental reasoning originates from axioms engraved in stone.
Most people eclectically ascribe to a mix of both patterns of thinking and perceive
both economic gains and environmental losses.

Yet, as the debate over the course of development took public form during the
1980s, one could rightfully interpret "economism" and "environmentalism" as
separate, incongruous secular religions.³ Although they are most noted for their
differences with respect to values, it is also important to bear in mind that each is
backed by different combinations of Western science and understanding,
different interpretations of the prospects for and consequences of new
technologies, and different judgments as to the appropriateness of alternative
responses to uncertainty.

During the 1980s, there was a positive feedback between how development
unfolded, the rise of new understandings, the shift in public views toward
environmentalism, and increased acceptance and demand for more participatory
approaches to development planning.⁴ These mutually reinforcing phenomena
provided the political base for environmental activists to challenge the most
visible development institutions and most unsustainable development projects.
The World Bank bore the brunt of the attack for its participation in the
Polonoreste Project located in Brazil's region of the Amazon tropical rainforest in
the State of Rondonia (Schwartzman 1986). During the clashes of the 1980s, both
economists and environmentalists pursued parts of their strategy successfully.
Economists effectively pressed the case for free markets to increase efficiency
and enhance the ability of developing countries to meet their debt obligations. At
the same time, environmentalists successfully convinced national governments to
establish biological reserves to protect key species, areas of unusual biodiversity,

³ Beckerman (1972) and Luten (1980) explore the dichotomous positions from the perspective of social and
natural scientists respectively.

⁴ The trend from a progressive to participatory approach in politics and administration parallels the trend in
science from the belief that the sciences would progressively merge into one correct way of understanding an
objective, static reality to the understanding that knowing is a human activity with multiple logical patterns of
thinking about the complexities of a world we have shaped and are continuing to shape. The importance of this
epistemological shift to economics is elaborated by Nelson (1991, Chapter 7) and by Norgaard (1989a).
and unique ecosystems. Without resolving primary conflicts, development activities assumed a bimodal nature—part conventional development, part biological conservation.

However, also during the 1980s, many environmentalists began to acknowledge that hungry people could neither live by nor leave biosphere reserves alone. With this realization, some environmentalists began to accept the challenges of designing and implementing alternative development strategies. Simultaneously, many in the international development community began to openly acknowledge the environmental consequences of conventional development.

An important third factor also contributed to the changing dynamic. Development planning and implementation continued to gradually shift in two apparently contradictory directions. At the project level, it clearly moved away from progressive technocratic toward more participatory approaches. The international development agencies began to work directly with nongovernmental organizations and to encourage the governments of developing countries to use them both for advice and project implementation. At the same time, the emphasis of development agencies shifted away from projects toward institution building, policy dialogue at the highest levels of government, and economic restructuring to meet lending criteria. The combination of these factors defused much of the debate between the two secular religions, transforming the conflict into a prolonged discourse on the meaning of and possibilities for sustainable development. The seminal work of the World Commission on Environment and Development institutionalized the exchange of views. (WCED 1987). During this period, international aid agencies as well as most national governments adopted the objective of sustainable development.

A decline of faith in the inevitability of progress is an important component of the international discourse on sustainability. Obviously if people had retained the faith they had in progress over the past several centuries, they would not be concerned about sustainability. Whether one believes in progress or not, of

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5 This transition might best be demarcated by the decision of the International Union for the Conservation of Nature and Natural Resources (IUCN) to design and implement conservation strategies in cooperation with national governments (IUCN 1980). The IUCN effort soon encountered the difficult questions of equity which they addressed in a major international conference on that theme (Jacobs and Munro 1987). IUCN is currently negotiating a new document that better incorporates the diverse concerns and knowledge of representatives and experts from the developing countries (IUCN, draft 1990).

6 This shift is confirmed and elaborated by Wilfried P. Thalwitz and Moeen Qureshi, two senior vice presidents of the World Bank (Qureshi 1991, Thalwitz 1991).

7 The World Bank established an environmental unit in 1971, initiated projects with environmental objectives in 1974; President Clausen (“Sustainable Development: The Global Imperative,” 1981) and President Consable (1986) spoke to the ecological basis of sustainability in their earliest speeches, and by 1987 sustainability was an announced policy (World Bank 1987; Le Prestre 1989).

8 Only 36% of Americans in early March 1991, at the peak of enthusiasm after “winning” the war with Iraq, thought the future for the next generation will be better than life today, up from 28% in June 1990 (Robin Toner, “Poll Finds Postwar Glow Dimmed by the Economy”). While critiques of the idea of progress date from the writing of Georges Sorel at the turn of the century (The Illusion of Progress, 1908) on through to Christopher Lasch in the present (The True and Only Heaven: Progress and Its Critics, 1991), attention to the decline in faith is relatively recent (Almond et al. 1982; Nesbit 1980).
course, has little impact on whether sustainability is actually a problem. Loss of faith is attributed in the developing world to the excessive promises of development relative to the results and in both the developing and the industrialized worlds to the recognition that new technologies inevitably have unforeseen, and perhaps catastrophic, environmental and social consequences.

The transition in beliefs led ethicists to ponder questions of intergenerational equity and the responsibilities of current generations to future generations. John Rawls's "veil of ignorance" (Rawls 1971) is often invoked with the question: "if you could not choose the generation into which you would be born, what rule for environmental and resource management would you choose?" If we accept the premise of environmental scientists that planet earth is fit for people because of the way nature evolved, all but incurable gamblers would choose a rule that assured that the natural patrimony stays intact between generations. Each generation would have the right to enjoy the services from natural assets, but the assets themselves must be passed on to the next generation.

In fact, such rules already exist for visitors to national parks, holders of riparian water rights, tenants of farmland and buildings, and beneficiaries of charitable trusts (Weiss, 1989). Environmental ethicists argue that the wide acceptance of the idea that development must be sustainable implies an extension of such contractual relations to the biosphere as a whole. Edith Brown Weiss integrates questions of intergenerational equity with issues of the rights of other species in an encompassing notion of "planetary trust" which assures communal and generational, rather than individual, rights. Her planetary trust concept accepts that people live in a global, intertemporal commons and have responsibilities to others as well as rights. Individual rights may be the best operational approach for specific cases, but Weiss makes a strong case that the notion that nature can be divided into parts, over time, generally assigned as individual rights does not constitute an appropriate, initial, overarching framework for approaching intergenerational equity.

During this final decade of the 20th century, there is a pastiche of dialogues between people with different economic, environmental, and ethical understandings working in international agencies and academic institutions. Joined by leaders of national governments, nongovernmental organizations, and traditional cultures, from industrial and developing nations alike, this discourse is steadily transforming our understanding of the desirable and the possible. At the same time, novel joint efforts between development agencies and nongovernmental environmental organizations such as the Tropical Forestry Action Plan are

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10 Rawl's veil of ignorance is used by Weiss (1989) in the derivation of her ethical position. See also D'Amato (1990), Glinding (1990), and Weiss (1990).

11 World Bank staff assumed a major role in this discourse. Key works by Bank staff and consultants include Ahmad et al. (1989), Colby (1990), Daly and Cobb (1989), Goodland and Ledec (1987), and Pezzey (1989).
providing new, shared, experiential knowledge.\textsuperscript{12} To a large extent the political challenge of sustainable development is past: sustainable development is accepted as policy. Elaborating policy goals into practice, however, still presents a considerable conceptual challenge in light of how earlier political and institutional environments affected the evolution of economic reasoning.

An important caveat is in order. Although there is considerable agreement that development must be sustainable, there is now less agreement on what development should be and how "it" might be achieved. This uncertainty is affecting the public’s perception of the nature of the problems which economists should address and the social environs in which economists work. The conceptual solution advocated in this paper for understanding sustainability, for example, has implications for how economists work with the political process. Thought and practice need to evolve in the context of three key factors.

First, with the decline in faith in progress, many peoples are expressing less interest in joining the "modern project" and more interest in defining development locally and in terms of their own cultures. The rising respect for cultural diversity [editor’s note: see Meredith, in this issue] is providing safer haven for tribal peoples while the revitalization of traditional cultures threatens the very existence of key nations. The search for sustainable development itself, furthermore, is leading in many directions. There is reason to argue that a culturally more diverse world might be more sustainable because it would not have "all of its eggs in the same basket." The environmental ravages of war stemming from cultural differences and the increased likelihood of ecoterrorism, however, could very easily more than offset this gain. In any case, the reculturalization of the world will affect how the benefits of different courses of development are perceived and the technologies used. These factors, in turn, will determine which environmental impacts are likely to occur, and what the pressures on particular resources will be.

Second, the dramatic rise of nongovernmental organizations is partly due to the inability of national governments and international agencies to design and implement projects technocratically from capital cities. Some interesting symbioses have evolved between large, central agencies and small, dispersed nongovernmental organizations. Yet nongovernmental organizations are also political forums for greater participation. With reculturalization and greater participation, projects are increasingly being designed to meet the minimum criteria of diverse parties rather than designed to meet a single efficiency criteria.

Third, progressive scientists and resource managers, responding to the summons to more fully manage environmental systems, have discovered that their knowledge is highly fragmented and not readily linked. While economists

\textsuperscript{12}The Tropical Forestry Action Plan (TFAP) was initiated in 1985 by the World Resources Institute with the help of the Rockefeller Foundation and joined by UNPAO, UNDP, the World Bank and eventually a wide variety of nongovernmental organizations, national governments, and bilateral aid organizations. TFAP’s chaotic evolution and mixed experience are leading to a major reorganization (Winterbottom 1990).
contemplated the optimal application of pesticides, agronomists could not show
the relationship between rates of use and crop yield; soil scientists and
hydrologists could not predict how much pesticide would actually end up in
groundwater aquifers; and agricultural chemists could not explain how pesticides
broke down in soils and beyond. Many have argued the need for a substantial
increase in environmental monitoring, yet, because our knowledge really is very
fragmented, we have little basis for determining what should be measured. Well
before the international development agencies accepted sustainability as a
development criteria, an accumulation of experience was forcing them to be
increasingly cognizant of interrelations between objectives and sectors as well as
more aware of the cultural context of the development process. Concern for
environmental linkages seriously compounded the number of interconnections
that needed to be considered.

The fragmented nature of our knowledge is a fact that has not gone away.
Economic analysts have to interact with environmental scientists directly to
assess the level of knowledge available in the design and analysis of projects. 13
Economic theory needs to develop in a way consonant with our increased
awareness of our limited understanding of the fragmented nature of knowledge
rather than assume coherence.

In light of the above, it is probably best to think of the participants in the
discourse on sustainability as being either “progressives” or “environmental-
ists.” Both progressives and environmentalists agree that there is an unacceptably
high likelihood that development as now implemented is unsustainable. This
unsustainable development path is illustrated in Figure 1 as the “consensus”
path. But there is disagreement on the course of action. Progressives believe that
sustainability will come through pushing the modern project to completion; most
assume a technocratic approach. They argue that sustainability will require a
significant expansion in agricultural, forestry, and other research to implement
more environmentally compatible technologies, and significantly more environ-
mental monitoring and assessment. Their approach is to design new institutions
to internalize external costs. They envision sustainability as a matter of fully
optimizing people’s interaction with nature.

Environmentalists view the challenge sustainability poses to the modern project
quite differently. They are split between technocrats who think the new
environmental scientists have reasonable answers and populists who put more
emphasis on changing values, reculturization, and developing traditional knowl-
dge. Technocratic environmentalists argue that there is little hope for achieving the
optimization required with higher levels of economic activity in light of the
inadequacies of current environmental management institutions and weaknesses in
systemic ways of understanding and manipulating the environment. Populist
environmentalists argue for new lifestyles with less technocratic hierarchy.

13 The nature of environmental science and how systems are understood is elaborated in Norgaard (1992).
Both environmental perspectives, however, believe sustainable development to be possible only if the overall level of economic activity is reduced. Redistribution of wealth to the poor in such a way that they will not become worse off in the process should follow. Finally, truly new technological and organizational alternatives capable of sustaining development will be developed.

Economists devised their theories to fit the way questions were asked within the technocratic social structure in which they worked. The rise in participation, the trend toward reculturization, and new epistemological understandings are affecting how economic problems are being defined and the organizational milieu in which economists operate.

The Challenge to Economic Thought

For some economic sectors, the course to sustainable development is clear. International assistance agencies, for example, are having little difficulty deciding the appropriate direction for energy sectors. Increasing the efficiency of power plants, transmission systems, and end-use appliances, while important to the reduction of greenhouse gases, is frequently justified on the grounds of narrow economic efficiency alone. The opportunities to invest in improved efficiency are considerable, giving us some time before we must determine how much additional investment is justified to stem global climate change. The sheer mass of opportunities for conservation certainly challenges the ability of the
international community to mobilize sufficient capital, expertise, and technology. Going from policy to practice in the energy sector, however, presents few challenges to economic thought and practice.

In contrast, the worldwide threat to tropical rainforests reflects a far greater challenge to a pragmatic understanding of sustainable development in the current period of transition between opposing world views. It is intellectually exciting, even emotionally inspiring, to be among the economists and ecologists exploring the multitude of relationships between economic and environmental systems. But the complexity of the issues reveals residual tensions, heightens appreciation of the inherent weaknesses of every conceptual construct for thinking about development, and is stimulating an acute awareness of the need to reach a consensus on how to reconnect values, knowing, and ways of organizing. Because of the local ecological and cultural complexities of tropical rainforests and because of their global importance to biodiversity and climate, picking and following a course of action has been especially difficult.

At first, economists presumed that this challenge could be met readily through minor elaborations on existing theory. Neoclassical economics is surprisingly malleable. It has been successfully applied to every sector of the economy, every factor of production, as well as to behavioral analyses from the level of the household through bureaucratic organization, and on to national and international politics. Because the market model has also aided our understanding of environmental management and the use of stock resources, achieving sustainable development was perceived as a matter of more fully using and extending thinking along these lines. There seemed to have been good reason to believe that through a mere shift in emphasis, an economics of sustainability would readily unfold.

Efforts to date at combining economic reasoning with sustainability reasoning, however, have not been very satisfying. In other applications, the concept of efficiency has helped explain how an objective can best be attained. But efficiency, at least as understood currently in the economics profession, rather than indicating something about the best way to achieve sustainability, frequently appears to conflict with the goal of sustainability. There is still a strong sense among economic policy makers that environmental objectives can only be reached at the expense of economic objectives rather than being included among economic objectives. This apparent conflict between efficiency and sustainability has thwarted the advancement of an economics of sustainable development.

Tropical rainforests provide some of the best examples of this apparent conflict. Of more than 800 million hectares of tropical forests designated for

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14 Such intellectual excitement can be found in the International Society of Ecological Economics (ISEE) which was formed in 1988 to further understanding between economists and ecologists and develop patterns of thinking and methods of analysis which go around current impasses (Costanza 1991). This group sponsors the journal Ecological Economics. The World Bank hosted the first international conference of ISEE in May 1990 and published summaries of the presentations (Costanza 1990).
timber production, only about 1 million hectares are now managed on a sustainable basis. (Poore 1989, p.196). From a narrow economic perspective, the reasons are clear. It is more profitable to cut without managing tropical rainforests for sustainable production because of a combination of factors including: (1) the low number of valuable tree species in the natural forest mix of species, (2) the difficulties of regenerating a reasonably natural mix of species or of controlling the mix at all, (3) slow rates of tree growth, and low prices due to (4) the relatively large global supply of rainforest resources and (5) the substitutability of timber and other rainforest wood products with temperate forest wood products. From a conventional economic perspective, it is wiser to deplete the forest and to invest the returns in more productive ventures, exploiting forests in an unsustainable manner in the process. Sustainability and efficiency, as economists typically understand them, seem to conflict.

Environmental economists argue that much of the contradiction between sustainability and efficiency is due to excessively narrow economic quantification. If both marketed and nonmarketed goods and services provided by rainforests are considered, sustainable management may be the most profitable strategy. The revenues that timber owners and lease holders receive are less than the total benefits of the forest hence they do not manage them to their full potential. Sustainable management, they argue, is more likely to be viable if external benefits are included in benefit-cost analyses.

Attempts have been made to measure the values of products used by indigenous peoples (Peters et al. 1989) of soil and watershed protection services (Southgate and Macke 1989), and of the future options maintained by protecting biological diversity (McNeely 1988, Dixon and Sherman 1990). In some cases, expanded benefit-cost analyses indeed seem to show that sustainable forest management is efficient (Hodgson and Dixon 1988, Peters et al. 1989). However, while internalizing externalities certainly increases efficiency, it need not increase sustainability. In the United States, for example, major petroleum resources in the public domain have been left undeveloped, not so much because Americans want to save resources for future generations, but because no settlements have been reached on how to compensate those among the current generation who would most directly bear the environmental costs.

But even in the cases where more efficient management leads to sustainability, there is a fundamental conceptual contradiction. Valuations of nonmarket goods and services are based on the preferences of the current generation and benefits accruing to future generations are discounted in net present value calculations to reflect what they are currently worth. To the extent expanded benefit-cost analyses “make the case” for sustainable forest management, they do so on the basis of the interests of current generations. Sustainability reasoning, on the other hand, weights current and future generations more or less equally. This key difference suggests it may be far more effective to think of sustainability as a matter of intergenerational equity.
SUSTAINABILITY AS INTERGENERATIONAL EQUITY

FIGURE 2. In an effort to avoid equity issues and work in the diagonally cross-hatched area, environmental economists have inappropriately restricted their use of their own theory.

Sustainability as Intergenerational Equity

The apparent conflict between sustainability and efficiency is resolved by thinking of sustainability as a matter of intergenerational equity. Different intergenerational distributions of rights result in new efficient allocations of resources and environmental services, different patterns of consumption and investment, and different factor and commodity prices including different interest rates. The appearance of a conflict reflects a long history of failure to incorporate equity in economic thinking. The overlap between economic and equity reasoning is illustrated in Figure 2. Environmental, forestry, and resource economists to date have basically tried to work only in the area that is diagonally striped, ignoring the horizontally striped area that includes equity considerations. Clearly the overlap between economic and environmental reasoning is greater when equity considerations are included.

While economists have concentrated their efforts on the efficient use of resources, environmentalists have consistently argued that societies need to consider how much resources they are leaving for future generations. The dialogue is over the distribution of rights to resources and environmental services between generations, not over how efficiently this generation exploits its current rights.\textsuperscript{15} The dialogue

\textsuperscript{15} Quite a few economists have approached the question of the long term but most have backed away. Talbot Page is one of the few economists who has seriously contemplated economics over multiple generations (Page 1977).
appears to juxtapose questions of efficiency and questions of equity, but a recognition that the efficient intertemporal allocation of resources depends upon the intergenerational distribution of rights to resources obviates this apparent conflict.

For noneconomists, the relationship between equity and efficiency can be illustrated as follows. Imagine two developing countries with identical land resources, produced capital goods, population levels, and educational levels. In country A, capital, land, and education are distributed relatively equally among the populace, while in country B they are distributed very unequally. Imagine that markets work perfectly in each country so that resources are efficiently allocated to produce the goods demanded in each country. But because of the differences in the distribution of resources, levels of income vary more in country B, resulting in different goods demanded. Resources, for example, might be allocated to the production of rice, chicken, and bicycles consumed widely by all in country A while in country B resources are allocated to beans for those with few resources and to beef and cars for those with many. Both economies are efficient, but the efficient allocation of resources to goods and services depends on the initial distribution of resources among people.

Many economists ignore the fact that there are multiple efficient solutions depending on how rights are distributed and have repeatedly referred to "trade-offs" that have to be made between efficiency and equity. There are certainly trade-offs between who benefits under one distribution and who benefits under another. Efficiency, however, is a measure of how well a goal is being met. Different goals such as growth regardless of equity or growth within certain equity constraints can each be met efficiently or not. The conflation in the literature has occurred because economists have implicitly assumed that maximum growth of GNP is the primary goal regardless of the inadequacy of the measure, of how it is generated, and of who receives it, and greater efficiency allows you to reach that goal. Any other goal is seen to be a constraint on the primary goal and hence a limitation on efficiency. The result is then referred to as a trade-off between efficiency and the other goal. While this conflation has become customary in economic discourse, it is theoretically incorrect. In political discourse it relegates all societal goals besides raw GNP growth to a secondary status, as things which conflict with the ideal of efficiency.

The relation between intertemporal allocative efficiency and the intergenerational distribution of resource and environmental rights is illustrated in Figure 3. The utility possibility frontier U indicates the highest utility possible for people in future generations for any given utility of people in the current generation, and vice versa. Each point on this frontier results from an efficient allocation of resources associated with different distributions of resource rights of caring between generations. Points within the frontier represent inefficient

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16 This diagram is the final step in a more complete elaboration developed by Francis Bator (1957) graphically illustrating the sequence of relationships between distribution, production, utility, and welfare.
FIGURE 3. A utility possibility frontier between generations with a social welfare function and a sustainability criterion.

allocations of resources. Clearly, there are many possible efficient allocations. Where a society is located on U is determined by the initial distribution of rights to productive assets, including natural assets.

Although Figure 3 is very simple, it illustrates an important point. Nearly all of the economic literature to date on sustainability stresses the importance of internalizing externalities. Development is conceived as a process of spurring economies to go faster; sustainability is conceived as a process of perfecting how economies work. Perfecting how economies work, however, will move the economy toward the efficiency frontier but may not make it any more sustainable. This dichotomy results in the continued stimulation of economies, even already developed economies, while sustainability waits for a perfection of market performance that has never yet been achieved and is unlikely to lead to sustainability if it is.

A few economists, realizing that sustainability is a matter of intergenerational equity, advocate constraints on the use of resources and environmental systems by the current generation.¹⁷ The constrained optimization advocated, however, is

¹⁷ Herman Daly advocated limiting resource use throughout and impositions on the environment beginning in the early 1970s and was roundly criticized for being an environmental determinist (Daly 1973). In the late 1980s, David Pearce, writing with numerous other authors (see bibliography), began to argue that sustainability and efficiency were not necessarily compatible and that efficiency should be constrained by environmental and resource limits to protect future generations. By taking up the argument later and not being specific about what the constraints might be, Pearce seems to have avoided the attacks absorbed by Daly.
FIGURE 4. Utility possibility frontier with a constraint imposed upon the current generation.

analogous to moving toward the efficiency frontier illustrated in Figure 4 but stopping at a vertical line, the environmental constraint on the current generation. To be effective, the constraint must be construed in terms of what is passed on to future generations. The current generation should be constrained to operate above the 45° line.

The best point on the U frontier in Figure 3 or 4 would be at the tangency with an intergenerational welfare function. Such a welfare function, of course, has never been revealed to economists. When it comes to equity decisions, economists must work with politics. The tenor of the political discourse certainly indicates that sustainability is at least a minimum intergenerational criterion on which there is broad consensus. While economists cannot determine how resource and environmental rights should be distributed across generations, they can more effectively engage in policy dialogue, helping countries to make their own decisions based on the understanding that sustainability is a matter of assuring that assets are available to future generations.

This distinction between treating sustainability as an intergenerational equity objective rather than as a technical constraint may appear to be unnecessarily subtle, but it is quite important for several reasons. The intergenerational framing elaborated through general equilibrium models in the next section documents how the apparent conflict between economic and environmental reasoning is to a large extent an artifact of the particular course along which economic thinking
evolved. Treating sustainability as an equity objective rather than as a technical constraint constructively reframes environmental, forestry, and resource economics as well as capital theory. Economic understandings which appear to conflict with the goal of sustainability are eliminated in an intertemporal general equilibrium approach that incorporates together intergenerational equity and the nature of resources. This approach, furthermore, identifies the importance of bequest and other motives and their supporting institutions for maintaining environmental systems and conserving natural capital.

Reframing Environmental, Forestry, and Resource Economics

Economic theory and practice will take some time to evolve around the broader, intergenerational equity framework outlined above. While the particular ways in which theory and practice might evolve are difficult to predict, the equity framework clearly identifies how prior thinking and practice in economics evolved too narrowly. The most powerful contribution of the broader framing is the perspective it provides for critically assessing the evolution of the subdisciplines of economics most directly concerned with resource use.

Although agricultural, environmental, forestry, and resource economics respond to public concerns for the long run, they do so without questioning the existing intergenerational distribution of rights. In the context of Figure 3, these subdisciplines have primarily addressed inefficiencies in resource allocation owing to market imperfections which leave the economy operating within the utility frontier. Solving such imperfections will in some cases move the economy toward sustainability, in other cases not. Corrections of market failures and other exercises in “getting the prices right” that are undertaken without redistributing rights to the future, under some circumstances, actually could reduce social welfare.

Since L.C. Gray’s article in 1913 and Harold Hotelling’s formulation of 1931, economists have pondered how exhaustible (stock or depletable) resources should be used over time. With the energy crisis of 1973–74, economists renewed their attention to the efficient allocation of exhaustible resources. Students of resource economics are now well aware of the “Hotelling rule” that the rent from a stock resource being exploited “optimally” increases at the rate of interest. The logic behind this rule is simply that a rational resource owner will maximize the net present value of the resource. If all owners deplete their resources rapidly, prices and rents fall. If all leave the resource in the ground, prices and rents rise rapidly. A solution results relative to other investment opportunities. If resource rents are increasing more slowly than the rate of interest over time, resource owners would be better off depleting the resource faster and putting the rent into other investments which yield the rate of interest. If rents are increasing faster

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18 Rents, also referred to as royalties, are revenues minus costs.
than the rate of interest, then leaving the resource in the ground is the best investment. Given these incentives, the equilibrium solution results in rents increasing at the rate of interest. As a "thought experiment" and pedantic device for getting students to think about resource use over time, Hotelling's argument has been extremely effective. But with modest complications in the assumptions, rents no longer rise at the rate of interest. Furthermore, efforts to explain historic mineral prices on the basis of Hotelling's reasoning have been unsuccessful.19

The literature repeatedly refers to the path of extraction from such "thought experiments" as the *optimal path*. The paths explored to date, however, have been merely *efficient* paths associated with the existing intergenerational distribution of rights to resources. Howarth and Norgaard recently demonstrated with a partial equilibrium, overlapping generations model how the efficient path of resource exploitation changes under different distributions of resource rights between generations (Howarth and Norgaard 1990).

One of the most interesting and contentious issues of natural asset management over time has centered on the question of "when should trees be cut?" In 1849, Faustmann determined the "optimal" rotation period for logging a forest by reasoning that the landowner "should" maximize the net return to forest land. This results in the following formula:

$$\max \pi(t) = p_s V(t) e^{-it} - \int_s^t r e^{-is} ds$$

where $t$ is time or rotation period, $p_s$ is the expected stumpage price, $V(t)$ is the biological production function (or yield) function for standing timber, $i$ is the landowner's discount rate, $r$ is the annual rental return on the land, and $s$ is a variable of integration.20 The formula has been expanded to incorporate, among other things, changing demand for timber, the possibilities for shifting between species, technological change, and nonmarket factors. But the initial premise of net present value maximization from which the basic formula and subsequent elaborations derive implicitly assumes that the current generation holds the land rights, unencumbered by obligations to or concern for future generations. The Faustmann formula has the property that if the value of the resource does not grow, on average, faster than the rate of interest, then harvest without replacement is optimal. This, indeed, is characteristic of tropical rainforests. But if future generations have rights to particular species, to species diversity, or even to the availability of timber at all, from the forest, then the current generation would have to maximize its net present value subject to these constraints imposed by the rights of future generations.

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20 This formula is elaborated further in a paper summarizing forest economics prepared for the World Bank by Hyde and Newman (1990).
Biological resources can be exploited in a nonrenewable manner since extinction is not reversible. Exploitative patterns of renewable resource use are frequently associated with the breakdown of institutions for common property management. The literature in environmental economics, however, also identifies the conditions under which it is "socially" efficient to exploit a species to extinction (Berck 1979; Fisher and Hanemann 1985, Pearce and Turner 1990, p. 268). Environmental, forestry, and resource economists have argued that efficiency rules may err in favor of excessive use by the present generation due to the existence of nonmarket factors. There is now a well-developed literature on methods for valuing nonmarket environmental services and numerous applications have been undertaken (Hufschmidt et al. 1983). Such approaches frequently do show that nonmarket goods and services have considerable value and that when these are included in economic analyses, the efficient path of resource use frequently shifts towards the future. But as a general means for assuring resources for future generations, expanding economic analysis to incorporate how this generation values nonmarket goods and services will not necessarily result in their being saved for the future. The coincidence between method and policy outcome may be largely due to the prior decision with respect to which nonmarket goods and services are valued and included in the expanded analysis. In any case, ultimately, we are concerned with maintaining natural assets for future generations because we sense that they will need these assets, not because we somehow value them.

Many societies, however, have already determined, largely by noneconomic reasoning, in other social decision-making arenas that future generations have rights to particular species, leaving the current generation without the right to exploit these species to extinction. International accords to protect endangered species and other agreements have also been made that limit the rights of and impose responsibilities on current generations. Whether it is "optimal" to extinguish a species is not simply a matter of determining whether its net present value is positive. Economic valuations provide insight. However, such values result from how economies operate within rules which are constantly changing through an interplay of decisions made within social arenas using different value systems, patterns of reasoning, and criteria.

The valuation of nonmarket goods and services is very important for assessing projects and policies from a public perspective. If the public's perspective, however, is that future generations should have more rights than they do now,

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21 This raises the awkward question as to the extent to which we value natural assets is already a reflection of our concern for the needs of future generations. Perhaps survey techniques could be used to determine the willingness of people in this generation to save natural assets so that future generations, rather than current generations, could utilize them. In some sense, the attempts at "option" valuation have this characteristic. On the other hand, environmental economists are least confident of deriving benefits for things which people themselves do not experience and about which they are unlikely to be informed (Smith 1990). More importantly, even if people could express such "values," are they not better considered a reflection of the welfare function than something that should be included in an efficiency analysis?
then valuation should be undertaken in the context of how the economy would behave if those rights were honored.

Economic values derive from how markets work under alternative institutional situations. When societies choose which institutions they prefer, values can be assessed. Values determined under inappropriate institutions tell us little about what institutions are appropriate. This is somewhat analogous to the current practice in benefit-cost analysis of valuing inputs and outputs at the costs and prices that would occur if the economy were not distorted by inappropriate government policies. The prices that result under inappropriate governmental policies only inform us of the need for appropriate policies relative to the prices that would occur under appropriate policies.22

Efficiency and caring for the future are not incompatible. The use of a general equilibrium model incorporating the relationship between intergenerational rights to assets and efficiency opens up environmental, forestry, and resource economics to a new framing of the future. Historically, these subdisciplines have implicitly constrained their analyses to the existing distribution of rights. As suggested in the introduction, this selective use of theory was compatible within the progressive institutional context in which economists found themselves during most of this century. The discourse over sustainability, however, is changing economic objectives as well as the institutional contexts in which economists work.

The Discount Rate Controversy

The international discourse on sustainable development was initiated by natural scientists, environmentalists, and others concerned with the maintenance of favorable environmental conditions over the long run. Whereas the long run might be as little as 10–25 years in most economic analyses, the long run for geologists is millennia and for biologists it is at least many generations. The discourse was joined by people concerned with cultural survival who also think in terms of multiple generations. This difference in outlook toward the future is critical. Participants in the discourse over sustainability are intensely aware that the standard economic practice of discounting benefits received and costs borne in the future automatically closes off the future. By framing sustainability as intergenerational equity, economics opens up to the future. With this reframing, the discount rate itself can be shown to be a function of how each generation cares about the next.

No doubt there exists an economist who has never experienced the slightest moral qualm over discounting the benefits to be received and the costs to be borne by future generations. Both the academic literature and discussions within

22 Both the use of "equity" prices and "efficiency" prices raise analogous issues with respect to the use of comparative statics when the real challenge is to determine the best path of adjustment.
development agencies, however, reflect considerable unease. With lower
discount rates, it appears more investments in forestry and a larger stock of
standing forests would be justified, favoring sustainability. Similarly, it appears
on preliminary analysis that lower rates of discount favor using stock resources
more slowly. Not surprisingly, many people concerned with the environment see
a strong link between the rate of discount, resource conservation, and the
sustainability of development.

Two strong theoretical arguments have been developed with respect to why
society should use a discount rate that is lower than the interest rates observable
in private markets. First, the rate used may be too high because market interest
rates include individual risk factors which are frequently only transfers between
individuals from the perspective of society (Arrow and Lind 1970). Second,
transfers to future generations may have a public good quality. Parents who
assure that their own offspring have access to resources in effect assure the
availability of these resources to their offspring’s spouses and children and to the
economy overall (Marglin 1963). These and other arguments have led many
economists to conclude that lower discount rates may be appropriate.

Within development agencies there has been particular concern for forestry
projects. Many trees take a long time to grow. Tropical forests can regain nearly
their original diversity after harvest, but a century may be needed. Because many
species of trees reproduce at less than current rates of interest, it is financially
unprofitable to grow them. Thus foresters and environmentalists concerned with
sustainable forestry have advocated using lower rates of interest to evaluate
forestry projects.

The arguments against using lower rates of discount in order to favor future
generations appear equally strong. Resource use and environmental transforma-
tions are undertaken in conjunction with produced capital. Labor used in resource
development and environmental transformation is also treated as a capital cost
since the development or transformation is seen as capital. Thus lower rates of
interest make resource development and environmental transformation relatively
less expensive and hence likely to be accelerated. Low interest rates favor the
investments necessary to transform diverse tropical rainforests into single species
plantations. A low interest rate policy benefits future generations about the same
way that a cheap food policy benefits the poor when most of the poor are farmers.

By reframing questions of the future in terms of the intergenerational
distribution of rights to natural and other assets, the case for using lower discount
rates to protect future generations becomes moot. If societies want to protect

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23 The widely felt concern about discounting distant future benefits and costs was recently documented in The
Economist (Anonymous, "What Price Posterity?" 1991). The academic literature on discounting is reviewed in the
context of the question of sustainability in a World Bank working paper by Markandya and Pearce (1988), in several
of the various recent books coauthored by Pearce, and by Norgaard and Howarth (1991).

24 Since stock resources are usually exploited in conjunction with capital, lower interest rates can lower the cost
of capital and thereby lower the cost of production such that more is consumed in early time periods relative to if
interest rates are higher, see Gordon (1966), Farzin (1984), Hartwick et al. (1986), and Lozada (1991).
future generations, they should assure their rights or otherwise care for them more. When they do, the investment opportunities for and savings of current generations, and hence the interest rate, change accordingly.

In theory, the rate of interest may increase or decrease in the transition to sustainable development, but this is unimportant because interest is simply an equilibriating price. What is important is that the types of investments and transfers to future generations change.

Transfers of rights to future generations are equity decisions, movements along the efficiency frontier from point B to point C in Figure 5, made in accordance with social welfare criteria. These would be movements from one level of transfer or caring to another. The benefits to future generations from shifting from one level of concern to another are not discounted. When comparing projects intended as investments, the returns are discounted.

There is nothing intrinsic about economies ensuring that living standards will continue to improve over time or even remain at current levels. The future will unfold from the choices, including sacrifices, made by our ancestors and those we make ourselves. The ongoing discussion within the profession of economics and international development agencies as to whether sustainable development and intergenerational equity can be addressed through ad hoc manipulations of the discount rate are rooted in an inappropriate theoretical framing of the choices before us. Matters of equity should be treated as such.

If we are concerned about the distribution of welfare across generations, then we should transfer wealth, not engage in inefficient investments. Transfer mechanisms might include setting aside natural resources and protecting environments, educating the young, and developing technologies for the
FIGURE 6. The transfer of natural and cultural assets assures opportunities for future generations.

sustainable management of renewable resources. Some of these might be viewed as worthwhile investments on the part of this generation, but to the extent their intent is to function as transfers, then they should not be evaluated as investments.

Distinguishing between investments to meet this generation’s consumption time preference and transfers to the next generation will not be easy. To the extent that the distinction can be made, there will be new reasons for concessional aid, especially for the very poor who will not be able to both assure the rights of future generations and provide for their own basic needs. The use of investment criteria based on meeting this generation’s consumption time preference is theoretically unjustifiable when it is the future’s needs that are at stake.

The Transfer of Natural and Other Assets to Future Generations

The simple diagram of Figure 3 can be modified to that presented in Figure 6 to elaborate how the transfer of assets between generations may have declined. Historically, the vast majority of natural assets were transferred from one generation to the next because people simply did not have the technology to deplete resources. But the transfer also occurred because parents knew their children’s survival depended on the same resources as did their own. Institutions also helped assure the sustainable management of resources used in common. In addition to the transfer of natural assets, the transfer of cultural assets—humanly produced capital, knowledge, and successful ways of organizing—from
generation to generation also assured sustainability. While not every culture was sustainable historically, many were for long periods of time. For these societies in these periods, the combination of natural and cultural assets transferred put them to the left of the 45° line.

When economists have pondered whether future generations will have adequate resources, they have argued, with few exceptions, that each generation thus far has become better off materially in spite of resource depletion, largely because of new technologies. In the context of Figure 6, the argument has been that cultural asset transfers more than outweighed any loss in natural asset transfers. As the best quality resources are used up, new technologies allow people to exploit lower quality resources or to find substitute materials. A famous analysis by Barnett and Morse (1963) seemed to document that the cost of obtaining resources had declined for nearly a century, indicating that resources were becoming more available rather than less, at least through 1957. Though studies undertaken during the late 1970s and early 1980s indicated that resource costs and prices had begun to increase, apparently indicating increasing scarcity, economists still frequently cite the study by Barnett and Morse to justify technological optimism.

Though the use of arguments using economic indicators of resource scarcity is commonplace in economics, such arguments are logically fallacious. Costs or prices can only be interpreted as indicators of scarcity in the contexts of the resource extraction models of Ricardo or Hotelling respectively. These models assume resource allocators are informed of resource scarcity. If they are informed, then their allocations and the resulting costs or prices will reflect the scarcity. If allocators are informed, however, economists could simply ask them whether resources are scarce or not. If allocators are not informed, the indicators will reflect their ignorance. There is no way to determine whether allocators are informed of resource scarcity or not unless those undertaking the analyses know themselves whether resources are scarce, which, is the very answer they hope to attain by the analyses in the first place (Norgaard 1990).

The general equilibrium framing developed in this paper indicates another reason why price or cost paths say little about scarcity. The multiple efficient solutions suggested above have different price and cost paths in accordance with how much people care about the future. The transfers made by parents, the forest conservation policies of national governments, and other factors affect economic indicators. For this reason, it is inappropriate to look to economic indicators to see whether resources are scarce. The indicators may not reflect scarcity, not because resources are not scarce, but because people have established institutions to redistribute resources in light of their scarcity. If those institutions are weakened

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25 The illustration in Figure 6 and the argument in the text suggests that natural and cultural assets are additive and that one can substitute for the other. Within limits this may be true, but certainly some of each are ultimately necessary.

26 The key later studies include Slade (1982) and Hall and Hall (1984).
because economists interpret their beneficial effect on prices as the absence of scarcity, resource use will accelerate and sustainability will suffer.

Early empirical work on the contribution of natural assets to current income in developing and developed countries is suggestive if not definitive with respect to the sustainability of development. A study by Repetto et al. (1989) of petroleum depletion, deforestation, and soil loss in Indonesia indicates that what appears to be a steady four-fold increase in gross domestic income in Indonesia between 1971 and 1984 may actually have been a highly erratic though apparently declining income after resource depletion is included in the analysis. Daly and Cobb (1989, Appendix) argue that sustainable economic welfare in the United States probably deteriorated slightly between 1970 and 1980 and appears to have deteriorated by somewhat more than one percent per year in the 1980s.

Clearly, whether societies are transferring more or fewer assets to future generations is still very much an empirical question in search of an adequate conceptual framing. The evidence is mixed. Certainly technology has advanced. However, industrial development, modern lifestyles, and even modern ways of organizing are closely tied to the net oxidation of hydrocarbons at the heart of the problem of global climate change. Many of these cultural assets, while available to future generations, are likely to be inappropriate. Many resources are not being transferred now because we have the technologies and levels of population to degrade resources we could never degrade before. New technologies, ways of organizing, and population levels have created a need for new transfer institutions. What little theoretical work has been done on the importance and nature of intergenerational transfers is probably insufficient to support significant empirical forays.

Social scientists are beginning to formally document how colonization followed by efforts at Western style development broke down traditional mechanisms of managing resources. Many have argued that the new institutions and technologies which replaced the earlier cultural capital hastened the rates of exploitation, assuring that there would be less to transfer. Colonial, and later national, governments assumed central control over forest resources in particular, both opening them up to commercial exploitation for international markets and

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27 One of the major difficulties in environmental accounting is that resource qualities and technology are closely interrelated. One can only be defined in the context of the other. As technology changes, qualities which were not appreciated before, and hence not thought of and inventoried as resources, become resources; see Norgaard (1975) and Norgaard and Leu (1986).

28 This study by Repetto et al. (1989) valued assets in terms of current market rents, i.e., current market prices less production costs. Income after adjusting for resource depletion varied tremendously due to oil price changes, so much so that the adjusted income loses all meaning. The problem is that relatively minor changes in market prices, when applied to the full stock of resources, result in very large changes in calculated income. Clearly, when supply and/or demand for a natural resource product are inelastic, relatively small changes in supply or demand will have large effects on price. Such price changes are necessary to equilibrate the market in that time period, but yearly price changes should not be used to value natural assets. Indeed, the price of farmland does not vary as much as the price of farm products, especially after deducting production costs, because investors in farm land realize most price changes are temporary. This study highlights one of the complexities of valuation.

29 d'Arge and Spash (1991), Cumberland (1991), and Page (1991) seem to be the only other economists beginning to frame questions in this manner.
closing them down to use by local peoples. The introduction of market incentives into village life shifted the incentive from savings in the form of land maintenance and improvement to savings in the form of monetary assets and Western-style human capital.  

Sustainability and Capital Theory: Dilemmas of Asset Aggregation

This discussion paper, like many other economic treatments of sustainability, argues that the assets—the natural, produced, and human capital—in each time period or generation must be at least as productive as those in the preceding period or generation. While this formulation has great intuitive appeal, aggregating capital, even simply produced capital, has proven difficult for numerous reasons. If knowing whether development is sustainable depends on actually determining whether aggregate capital is increasing, a review of the controversies in capital theory is in order.

Capital is heterogeneous. Some assets have short lives, some long; some produce evenly over time and then suddenly expire, some produce proportionately less over time and whither away; some, like trees, have long start-up times, produce different products over their lifetimes, and then can be harvested during any of several years. The typical approach to aggregating across capital of different lifespans and productivity time paths entails summing the net present values of each of the assets over their lifetimes. This method fits our understanding of how sales prices for corporations with multiple capital assets are determined. This approach, however, runs into difficulties when applied to economies as a whole.

The Cambridge–Cambridge controversy is still unresolved. Though empiricists have yet to find the argument significant, the controversy has highlighted the fact that aggregation rules are necessarily based on assumptions about the nature of economic systems which may prove contentious. In particular, the

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30 The number of social scientists working in this area is now sufficiently large that there are established, though still very much overlapping, schools of thought. The largest focuses on institutions, typically at the community level, which have historically managed common property resources. Economists have worked actively with sociologists in this effort, reviewed in a World Bank Discussion Paper by Bromley and Cernes (1988). A second group, under the rubric of political ecology, concentrates on national and international institutions. Representative works include: Blaikie (1985), Redclift (1987), and Shiva (1988). A third group, who have assumed the name of "environmental history" combine the thinking of the first two and concentrate on historical documentation. The works by Guha (1990) and Gadgil and Guha (1992) are excellent examples from the developing world of the work underway in the area of environmental history. Worster (1988) and Merchant (1980) are leaders in the field in the developed world.


32 Joan Robinson argued that since the total quantity of capital in an economy at a particular time, how capital is used over time, and how capital services are aggregated all depend on the rate of interest, there is a possibility that the relationship between aggregate capital and the rate of interest is not monotonic. When this phenomena is combined with the possibility of backward bending supply curves for labor, the relationship between the capital intensity of different techniques used at different interest rates is not smooth. There is, in effect, the possibility of switching and reswitching between techniques of production as interest rates decline or rise relative to wages. And if this is the case, very different, i.e., incomparable, bundles of capital are being discussed at only somewhat different interest rates. The Cambridge-Cambridge controversy is reviewed from at least half a dozen perspectives in Eatwell et al. (1990).
controversy highlights the complexities introduced by the relationships between production techniques and capital aggregation, complexities that parallel the difficulties of valuing natural assets independently of technology. How can things be valued and compared when they are inherently interrelated, i.e., not separate things? New conventions will have to evolve to work with the dilemmas of measuring and comparing separate natural, produced, and human assets when they, in fact, are inseparable.

The Cambridge–Cambridge controversy stressed how values change moving between equilibria points. On the presumption that the transition to sustainability will entail a significant shift in the economy, this aspect of the controversy is important. Thinking back to the utility frontiers between current and future generations of earlier diagrams, the measurement of aggregate capital at an interior point (such as A), the closest efficient point (B), and the welfare maximizing point (C) will all be different because they use different rates of interest and prices. At point B, the total assets passed on to the next generation will be less than those enjoyed by the current generation; at point C the total assets passed on to the next generations are greater than those enjoyed by the current generation. However, one cannot compare the aggregate values of assets at points B and C as they would be measured at their respective points. Due to price effects associated with the scarcity of natural assets and the change in the rate of interest, the aggregate value passed to the next generation at B could be greater than the value at C and yet B clearly would still not be sustainable. The net present value of assets can stay the same or even increase when both the flows and the rate of interest decrease. Thus environmental and resource accounting relies on a monotonic relationship between capital and the rate of interest much the same as does the concept of aggregate capital for aggregate production functions.

Aggregating capital may blur whether sustainability is possible for another reason. Generation 1 might pass trees on to generation 2 with a net present value equal to the assets generation 1 received. But if these trees need to grow another 30 years and can only have the stipulated value if they in fact are not used until generation 3, then the rule does not lead to sustainable development. In short, the time period during which capital can be used is critical to our understanding of sustainability but are blurred through aggregation.

From the perspective of sustainability, emphasis must be placed on the continuity of flow, not some measure of aggregate value. In this sense, each generation is obligated to pass on to the next a mix of assets which provides equal or greater flows to the next generation without greater effort on that generation's part to provide the same for the next. Given a choice between several possible assets, the appropriate question is "how well does an asset's flow of services match those of existing assets to meet the welfare objectives for each generation?"

After the energy crisis of 1973–74, several economists used growth models with both aggregate physical capital and exhaustible resources to explore the
conditions for sustainability. Out of these explorations emerged what has become known as the "Hartwick" rule which states that consumption can remain constant in the face of declining availability of exhaustible resources so long as the rents from the exhaustible resource are invested in renewable capital. While these models were touted at the time and have been since as evidence that development can be sustained in the face of natural resource exhaustion, in fact, closer analysis reveals that these models only identify the importance of substitutability. As long as a renewable form of capital can substitute for the depleted natural capital for all productive purposes, development can be sustained. Common sense indicates that if something is not essential, its demise is not critical. These growth models illustrate why the role of natural capital in sustainability often hinge on the extent to which natural capital is special.

For economists, comparison and aggregation are greatly simplified by valuation. Sustainability requires, however, that equal attention must be given to the mix of specific assets and the timing of their flow of services. Though the aggregate measures of economists will no doubt assist in the overall assessment, the limitations of capital aggregation explored in this section provide excellent justification for sustaining development in part through the protection and transfer of particular types of assets as determined by noneconomic reasoning.

The Challenge to Economic Practice

The practice of economics and the organizational environment in which economists work evolves with social concerns and the theory used to address them. There is every reason to believe that economic practice will evolve to accommodate sustainability insofar as it may be considered a matter of designing new and bolstering existing institutions to transfer assets. However, the history of the practice of economics documents that the methodological stance of positivism has clearly selected against serious involvement with questions of equity. Sustainability challenges the profession to respond to shifts in the political arenas in which decisions are being made about which assets should be saved for future generations and how institutions should be augmented to maintain and transfer assets.

The international development agencies were initially conceived in the progressive vision as mechanisms for transferring knowledge, technology, and capital from industrial nations to the less developed world. In this formulation, the

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34 For stock resources which do not have substitutes, economists have built models in which resource use asymptotically goes to zero and output is maintained, but these rely on a Cobb-Douglas specification in which the average product of the stock resource goes to infinity as use goes to zero. Barnett and Morse (1963) also argue that substitution has been a key factor relieving scarcity. Following this argument, some economists have argued that resources with high elasticities of substitution cannot by definition be scarce. Ehrlich (1989) tackles economists' reliance on substitution arguments from the perspective of environmental science.
United Nations agencies provided advice on specific issues and the international banks assessed specific development projects proposed for loans. Economists helped select, on the basis of efficiency criteria, what should be presented to agency governing bodies and developing governments for consideration. Unique recommendations are obtained, most typically, by implicitly assuming the current distribution of rights, both within and across generations.

Development economists were initially seen as working apart from politics, independently assessing and advising on separate things, with the flow of information clearly going from North to South. The evolution of environmental, forestry, and resource economics in North America took place in a very similar organizational environment. Interpreting sustainability as a matter of correcting market failures fits nicely within this organizational role. Taking the existing distribution of assets as given, of course, has been an equity stance, but few among the public at large knew sufficient economics to effectively expose this position.

The practice and organization of development economics, however, did evolve. Advice-giving agencies have become integrally involved in national planning and institution building as well as in project formulation and implementation. Separate advising on specific aspects of development made little sense. However, in spite of continuing efforts to initiate development projects and policies correctly, it is commonly acknowledged that international efforts to promote development fall short because the institutions established lose direction, knowledge transferred is not retained and disseminated, educational facilities soon lack teachers, and irrigation projects are not maintained.

Efforts to address such problems have led the international agencies in contradictory directions—to try in some cases to shift responsibility to local communities and nongovernmental organizations and in other cases to assume broader responsibility themselves, centrally directing aid in response to how well nations are managing projects and maintaining institutions.

Concern over the sustainability of development has accentuated the issue of development maintenance. When environmental institutions have high "decay rates," environmental monitoring and protection will soon be inadequate. Industrial projects require ongoing maintenance and management to keep pollution levels low. Forestry projects require a balance between growth and cutting as well as road building and erosion control that can easily tip the wrong way when management is not sustained. Modern agriculture requires sustained research simply to maintain levels of productivity because pests overcome the resistance bred into modern varieties. Sustainable development requires vigilant, day-to-day, appropriate interaction with the complexities of ecosystems. Unlike the progressive vision, development is not a process of figuring things out and setting them up correctly once and for all.35

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35 The significance of sustaining development for the World Bank, for example, has been described by the Operations Evaluation Department (World Bank 1989b).
Formulating sustainability as an equity decision also confronts positivism directly since economists can no longer distinguish between development possibilities using efficiency criteria rooted in the current distribution of rights between generations. If the economy could be moved from B to C in Figure 5 with a few legislative changes in a matter of years, economists could “wait out” the transition and then undertake conventional efficiency analyses after a new regime of rights was established. In fact, there is no reason to expect the transition to sustainability will be quick.

Assuring the rights of future generations will be an ongoing, complicated process. To some extent it will be a matter of determining and protecting the local and national mechanisms—cultural, market, and public—that already exist for transferring assets to future generations. Legislative decisions to protect individual species, set aside land for national parks, establish soil conservation agencies, and limit pollution can be interpreted as efforts to protect the rights of future generations. Judicial branches of government will reinterpret legislative law and develop rationales for decisions in new areas. International accords such as the Montreal Protocol to protect the ozone shield clearly limit the rights of current peoples in order to protect the assets of future peoples. An international greenhouse gas accord of much greater significance is likely. The international agencies have been mandated to promote sustainable development on a project by project basis. And international agencies, national governments, and nongovernmental organizations have joined in the Tropical Forestry Action Plan to save tropical forests for future generations through a complex administrative process.

The principle that future peoples have rights to human capital in the form of education and health are equally important and assured by a combination of shared ethics, constitutional clauses, national legislation, and international accords which established United Nations agencies to promote these ends. In short, the rights of future generations will be protected by an incoherent, constantly evolving pastiche of formal legislation and informal agreements. Economists might be able to help make it more coherent, but it would be naive to presume that the rights of future generations will be assured by a few simple rules. We can expect the process to be represented by the zig-zag path from A to C in Figure 7.

Given that many decisions of great economic importance will be made in noneconomic decision-making arenas, what should be the role of economists? Economists need not be simply reactive, technocratically responding to new rules aimed at intergenerational equity made in other arenas. A higher portion of economists might take proactive roles, closer to the classical liberal view of the interdependence between economics and politics. Economists should actively propose what they think are the best methods for protecting the interests of future generations and question the effectiveness of proposals put forth by others. They should openly participate in the political discourse through which the strategies for achieving sustainability are being selected. This, however, would require a
significant shift in the stance these economists take toward political and other social decision-making processes.

The technocratic progressive stance, in which economists see their role as keeping politics on track through the use of efficiency arguments, is still dominant. In the last decade, there has been a significant rise in the number of neoconservative economists taking the view that any form of collective activity is irrational. More recently, however, some economists have joined with other social scientists to reinvigorate the classical position. In the classical view, markets, politics, administration, and the judiciary are separate social decision-making arenas. Decisions within each of the arenas affect the other arenas. Progressive technocratic and neoconservative economists see all decision making as simply a matter of weighing aggregate benefits and costs, a process which markets do for individual consumers automatically and arguably as well as possible. In contrast, the classical view stresses how people participating as citizens engaged in the political process use different procedures, languages of discourse, and criteria than they use as consumers participating in markets. In the reviving classical view, people are not simply utility maximizers. They think and act in different modes as members of families, as citizens of cities, states, and nations; as laborers, professionals, or capitalists; as participants in judicial

36 Amitai Etzioni (1988) from the perspective of a sociologist primarily concerned with community and equity and Mark Sagoff (1988) from the perspective of a moral philosopher primarily concerned with the environment argue persuasively that politics is a form of moral discourse directed at creating the kind of society people desire. Amitai Etzioni has spearheaded the formation of the Society for the Advancement of Socio-Economics to foster communication between economists and other social scientists and to support a "healthier" attitude among economists toward other social decision-making arenas.
procedures; as religious beings; and as consumers. For each of these personas, the reviving classical view stresses shared discourse and learning as it contributes to the development of understanding and formation of preferences, rather than thinking of decision-making as an informed weighing of given preferences.  

Classical interpretations of the interplay between people as consumers satisfying their individual wants and people as citizens striving to reshape the world provides considerable insight into the organizational challenge that sustainability presents to the practice of economics. Economists tend to think that decisions in all arenas should meet tests of economic rationality, of the weighing of benefits and costs. However, if benefits and costs are functions of how rights are assigned, decisions to change rights cannot possibly be put to an economic test.

Economists can still participate effectively in these other decision arenas. They can still assess how different strategies under consideration would actually work if implemented. Efficiency criteria could not be used, but economists could explore how much the current generation might have to forego in order to assure future income. Economics as a pattern of thinking identifies issues that other social and environmental sciences miss. For example, economists might try to predict how national economies will respond and interact globally to alternative rules for greenhouse gas reduction. Economics is critical, not in the sense that it provides criteria by which other arguments are tested, but as one way among many for seeking a larger understanding.

At an operational level within the existing structure of economic practice, thinking of sustainability as intergenerational equity suggests that development agencies need to be paying more attention to asset maintenance and transfer. In this light, the practice of economics needs to shift from concern with efficiency to concern with both efficiency and transfers. Considerable background work is needed which might best start within or be fostered by the international development agencies themselves. These include:

**Analyses of Transfer Institutions**

Both historical and cross cultural analyses of the effectiveness of alternative institutions affecting how assets have been transferred between generations are needed. Economists, and more recently anthropologists, historians, political scientists, and sociologists, have made very important contributions to our

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37 This "classical" position is also known as "republicanism" in reference to its support for a republican form of government consisting of active citizen-voters. Lasch (1991) draws heavily on this distinction in his new left critique of the old left's politics of materialism, wending these concerns deftly with the current perception that unlimited materialism will destroy the environment that supports us. Also from the political left, Bowles and Gintis (1986) argue for an expansion of democratic decision making into what are now the economic and administrative realms in part to elevate workers/consumers from mere preference sorters to learning beings. Key republican revivalists nearer the center of political views include Bellah and diverse cohorts (1985), Sullivan (1986), and Wolfe (1989). The concerns for community expressed by Daly and Cobb (1989) fit this philosophy as well.
understanding of institutions for managing environmental systems. The linkages between how institutions affect environmental management and how they affect bequests to future generations need to be understood and to become part of political discourse. Such analyses need to be undertaken on a country-by-country basis and within regions for the larger countries. Economists and other social scientists in international development agencies could initiate such analyses and demonstrate their importance. Ongoing research might then best be undertaken by academics supported by national governments and nongovernmental organizations. Development strategies should then be designed to favor institutions supporting the transfer of assets and discourage those which are not.

Analyses of Current Levels of Asset Transfer

While there is now widespread concern that development is not sustainable, existing data on services from natural and other assets are inadequate and methods for aggregation are not appropriate. The efforts by the United Nations Statistical Office to develop environmental and resource accounting data and methods could be augmented with greater efforts by other development agencies. Environmental accounting methods and ways of using the data will evolve best through experimentation. As per the arguments developed above, methods for assessing yearly flows from multiple assets rather than the aggregation of assets are especially needed. Development strategies should be formulated in light of what can be known about the levels of asset transfer.

Evolution of Rules for Appraisal of Projects with Transfer Components

Projects will be seen increasingly as having two components: an investment component which should provide a return on current savings and a transfer component designed to help meet intergenerational equity objectives. The distinction between these two components, however, will rarely be clear. Rules, analogous perhaps to the rules for the division of costs between joint products in financial analyses, will need to be developed through experience and rational discourse within the agencies.

Increasingly, international development agencies will become involved in transfers of financial capital with the primary aim of promoting intergenerational equity. The objective of the new Global Environmental Facility jointly run by the World Bank, United Nations Development Programme, and United Nations Environment Programme is to provide financial transfers from industrialized nations to developing nations to protect biodiversity, limit greenhouse emissions, and protect the ozone layer. If the capital endowment of the Facility is substantially increased, it could become a major player in facilitating the transfers needed for sustainable development.

Whether participating in political and other decision arenas or working within development agencies, economists will find themselves striving for optima which
are not consistent with the limited data, the unreliability of environmental institutions, the vulnerability of managers, and the vagaries of nature. Questions concerning the interactions of social and environmental systems over long time periods are inherently complex, the likelihood that optimization reasoning will err on the unsafe side are high, and the consequences are likely to be very costly. To the extent this characterizes the search for sustainability, there is good reason to seek minimum-regret solutions and safe minimum standards (Ciriacy-Wantrup 1986; Perrings 1991).

In all of these roles, the international agencies can assist by contributing to the global view necessary for the efficient distribution and allocation of exhaustible resources. At this stage, relatively little is known about how to transfer capital to another nation and assure that global objectives are met. With sufficient North-South transfers or debt cancellation, for example, the tropical rainforest nations may indeed establish very effective controls on deforestation. Northern economies, however, may choose to accelerate economic activity in order to support the transfer. The transfers may also stimulate energy-intensive development in the South. Both effects could contribute even more to global warming and ultimately to the loss of biodiversity. Transfers between generations and between North and South may have little effect in the medium to longer run if there are few new technologies and only a narrow field of development strategies between which nations can choose. There is good reason to believe that transfers can contribute to a solution, but they are probably not a solution in themselves.

While successful middle and upper income participants in the modern global economy have less control over the process of asset transfer, the poor increasingly simply have nothing to transfer. The more than a billion people, approximately 20 percent of the world’s population, living on less than one U.S. dollar per day must necessarily worry about their immediate needs. About as many people have higher standards of living but insecure title to the resources they manage, reducing their incentive to manage them well for their children. Drought, floods, hurricanes, and earthquakes disrupt the management and accumulation of natural and other assets periodically for many other peoples. Tribal, civil, and regional warfare interrupt resource management, education, and capital accumulation for millions of others. To a large extent, enhancing the transfer of natural and other assets will require substantial improvements for those most vulnerable now. Intergenerational equity and infragenerational equity are complementary objectives.

During the rise of industrial development, the question of whether this generation’s income has been obtained at the expense of the next was subsumed by our faith in technological progress. Future generations would be taken care of by a process of “trickle ahead” much like we once believed that the poor would automatically benefit from development through “trickle down.” With the weakening in the faith in progress, “trickle ahead” is being questioned openly.
Modern societies have not developed institutions to assure the needs of future
generations. Quite the contrary, modernity appears to have broken down previous
management and transfer institutions. There is a significant possibility that the
growth in income associated with development has come from the use of
resources that had heretofore been protected for future generations. The provision
of "future needs" through natural and other asset management and transfer must
become a criterion for development on a par with the provision of "basic needs."
The possible arrival of an international "grants economy" suggests a host of new
questions that will need to be explored and new types of practices to which
economists may contribute.

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