The Economics of God's Creation

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Seniority of authorship is shared equally. Barrett's work was supported by a grant from the Pew Evangelical Scholars Program. Any remaining errors are ours alone.

By God and for God all things were created, in heaven and on earth, seen and unseen. As proclaimed in the Nicene Creed, many Christians consider these truths central to the faith. Thus, creation is the *cosmos* of John 3:16 and should be of first-order interest to Christians. We are stewards of God's creation. Meanwhile, it is now widely recognized that change in the natural environment can have an impact on the economy and that economic activity likewise commonly affects the biosphere. Over the last generation economists have thus begun paying considerably greater attention to questions of environmental valuation and management. The economics of God's creation is therefore of increasingly general interest to Christian economists.

In this paper, we consider an incomplete sample of major topics explored in the field of environmental-resource-ecological economics (EREE). This brief review is meant to familiarize the nonspecialist with some, although by no means all, basic points of the EREE literature, framed so as to highlight issues and relationships of fundamental concern to Christians. We try also to note the major contributions of Christian economists known to us, although our ignorance of the religious convictions of most of the many economists writing on these topics condemn our efforts to be incomplete. The reader seeking more complete and detailed treatment is advised to consult any of several good, recent texts and survey papers in the EREE field (Costanza et al. 1997; Cropper and Oates 1992; Freeman 1993; Hanley et al. 1997; Oates 1992; Pearce and Turner 1990).

Environmental-Resource-Ecological Economics

A common question among people from outside the field is what is the difference between environmental, resource and ecological economics? This question offers a good place to begin, for the subtle differences between these highly interrelated literatures help us to distinguish among core subjects. The environmental economics literature concentrates primarily on two topics: the control of environmental externalities such as pollution and, relatedly, the valuation of environmental amenities that are at least partly nonrival, nonexcludable or subject to uncertainty. Environmental economics thus rests heavily on the theory of externalities, and its

offshoots: cost-benefit analysis and optimal regulation. Resource economics concerns the optimal intertemporal management of renewable (e.g., forests, fisheries, wildlife) and nonrenewable (e.g., hydrocarbons and minerals) exhaustible resources. Resource economics tends to be closely related to population ecology and to rely heavily on dynamic optimization methods. Ecological economics draws heavily on systems ecology, emphasizing the interrelationship between the economy and its supporting ecosystems. Ecological economics therefore focuses heavily on issues of sustainable development, an ill-defined but popular term, and tends toward multidisciplinary studies and methodological heterodoxy.

The valuation of the stock of natural resources, the goods and services provided by nature, or both is a common core concern of each of the three strands of the literature. So the next and largest section of this review essay considers valuation questions. Economic values are inherently anthropocentric, as we discuss below, and this valuation guides efficient resource allocation within and across societies. So the two subsequent sections then consider a variety of the core applied issues in the literature through the lens of intra- and inter-generational resource distribution, highlighting how questions of environmental and natural resource management often have issues of distributive or procedural justice at their core. Such concerns are common fare for many Christian economists, although not always front and center in the field.

Valuing God's Creation

Estimating the economic value of goods and services is one of the mainstay activities of professional economists. Economists have well established and accepted theory and techniques for estimating the economic value of typical commodities bought and sold in economic markets, such as food, clothes, housing and automobiles. In general, the market sets the marginal exchange value, or price, of these commodities, as observed on the food package, clothes tag, real-estate listing, or automobile sticker.

But what about goods and services provided by God's creation? Can we estimate the economic value or put a price on these provisions? God's creation refers to all those things recorded in the creation story reported in Genesis: the heavens (including outer space, the stars, and the atmosphere), the earth, and all that is within and about the earth, e.g., soil, water, rocks, minerals, plants, animals, and people. God's creation and its natural regenerative properties meet human demand for nature as both an amenity to be enjoyed and as an input into production processes. Unlike typical market processes, in which the supplier of goods or services demands compensation, God's creation, like its new creation in Christ's resurrection, is a gift given freely by God. The pricelessness of the gift, however, confounds its valuation.

In this paper, we focus on the biotic and abiotic components of God's creation, henceforth labeled *nature*. God created people distinct from and with a special status over plants, animals, and the nonliving elements of nature. As a group, economists have an anthropocentric or human-centered view of nature and natural resource valuation. Other scientists and philosophers may have a biocentric view which puts people, plants, and animals on an equal footing and status, or an ecocentric perspective that focuses on the total system of which people are but one part. Biocentrists or ecocentrists often argue that people have no special right to value nature in the first place (Barrett and Grizzle 1998a,b; Burrell 1996; Finger 1993). To such people, the question, "What is the economic value of plants, animals and other elements of nature?" is deemed irrelevant or even offensive.

Scripture clearly affirms, however, the special role and responsibility people have been given over nature. Only people, the Scriptures teach, were created in the "image of God." Moreover, God appointed people to act as stewards of nature. The role of steward by no means gives people

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the right to overuse or abuse nature. Rather, people are charged by God with the responsibility of carefully tending nature in the same way a wise and prudent gardener would tend his or her garden. The roles and responsibilities of people as "good stewards" over nature have been articulated by many Christian writers (Barrett 1996; Barrett and Grizzle 1998a; Basney 1994; Daly and Cobb 1989; DeWitt 1993; Kapur 1993; Marshall 1996; Nicholls 1993; Schaeffer and Middleman 1992; Wise 1987; Wright 1993). With stewardship rights and responsibilities God gives humankind the right to name otherkind, as described in Genesis. So to do they convey the right to appropriately value God's creation so as to steward or manage it properly.

The Book of Leviticus, for example, gives instructions for appropriately valuing or pricing land in ancient Israel, based on the value of the crops grown on the land over a certain period of time (Leviticus 23). This has obvious parallels to modern agricultural land valuation techniques focusing on the capitalized value of the stream of net revenues associated with a resource. Pentateuchal instructions indicate that natural resource valuation should not be arbitrary and must include provisions for fairness. For example, the time horizon for determining the value of agricultural land based on expected future crop is set in Leviticus 23 as the number of years to the next 50-year jubilee, when land is redistributed.

A crucial distinction must be drawn, however, between economic valuation of nature and nature's noneconomic value. While it may be right, necessary and possible to estimate the economic value of nature, it must be kept in mind that this is only a *partial* valuation of creation. Many Christian scholars have emphasized the interconnectedness and interdependence of nature in their writings (Barrett and Grizzle 1998a,b; Daly and Cobb 1989; Finger 1993; Wright 1993). This interconnectedness means that elements of nature have biocentric and ecocentric intrinsic and instrumental value, as discussed below. For example, plants have biocentric instrumental value to herbivore animals as a source of food which contributes to the biocentric intrinsic value of "good health" to herbivore animals. Biocentric and ecocentric instrumental and intrinsic values are not based on human preferences and therefore fall outside the realm of anthropocentric economic valuation theory and techniques.

The noneconomic value of nature discussed most often and emphatically by Christian philosophers, scientists and other writers is theistic intrinsic value. The source of theistic intrinsic value is the inherent worth or goodness that God places on nature. Theistic intrinsic value therefore is God-centered rather than human-centered and cannot be valued using human preference based economic valuation theory and techniques. So, to put the economic valuation of nature in its proper context, we need to first define and discuss different types of values of nature. Then we briefly discuss the most common valuation methods applied in the literature today.

Theistic Intrinsic Value

The first general notion of nature value to be discussed is *intrinsic value,* the inherent worth or goodness of something. The Bible has many references to the inherent worth or goodness of nature. This intrinsic value derives from the Creator (Psalm 104). Just as a painting is inherently worthy and good to the one who painted it (regardless of what other people think!), every plant, animal, rock, or mineral has inherent worth and goodness to God the Creator. This theistic intrinsic value of a natural resource is independent of people. A number of Christian philosophers and scientists make reference to the theistic intrinsic value of God's natural creation in their writings (Bratton 1987; Kapur 1993; Nicholls 1993; Van Dyke 1993; Wright 1993).

Biocentric Intrinsic and Instrumental Values

Theistic intrinsic value is the inherent

goodness of nature to God and is independent of people and other creatures. Nature's value may also derive from and be dependent upon people, plants and animals. Biocentric intrinsic values, in general, can be thought of as what is inherently "good" to plants and animals. Good health, for example, is an intrinsic value experienced by both plants and animals. Nature's biocentric instrumental values are the value of things as inputs contributing to the generation of biocentric intrinsic values. For example, in nature, other animals have instrumental value to carnivore animals as food which contributes to the intrinsic value of the good health nutrition of the carnivore. Other animals, however, do not have instrumental value as food (but perhaps in other ways) to herbivore animals (Bergstrom and Loomis, 1998). Biocentric instrumental values matter, at a minimum, indirectly because nonhuman biota themselves have theistic intrinsic value. Unless nonhuman biota have absolutely no rights, a difficult case to make theologically (Nash 1993) , biocentric instrumental values also matter directly.

Anthropocentric Intrinsic and Instrumental Values

Anthropocentric intrinsic values, in general, are basic needs, desires and feelings that people hold to be "good" such as health, security, love, and contentment (Ferre 1988). Nature contributes to these anthropocentric values through anthropocentric instrumental values. Anthropocentric instrumental values are the values of things as inputs contributing to the generation of anthropocentric intrinsic values. For example, wildlife has instrumental values to hunters and birdwatchers as inputs into the generation of intrinsic values associated with recreational activities (Bergstrom and Loomis, 1998).

Economic Value and Valuation

Theistic intrinsic values, biocentric intrinsic values, and biocentric instrumental values exist independently of people. Economic valuation techniques depend upon people and their preferences. Thus, theistic intrinsic values, biocentric intrinsic values, and biocentric instrumental values inherently cannot be valued using economic valuation techniques. Theistic intrinsic values are spiritual and are therefore more appropriately examined using methods of theological inquiry. Biocentric instrumental and intrinsic values are more appropriately examined using biological and ecological methodologies.

Economic valuation techniques focus on the measurement of anthropocentric intrinsic and instrumental values, in particular, anthropocentric instrumental values (Costanza et al. 1997). Economists are very familiar with conceptualizing and estimating the value of inputs into the production of economic goods and services consumed by people. How do economists measure the anthropocentric instrumental values of elements of nature? When utilized as inputs into economic production, elements of nature are often bought and sold in input markets. For example, exhaustible nonrenewable resources such as crude oil and phosphate rock, which are processed into fuel and fertilizer inputs, are bought and sold in established raw material markets. Prices arising in these markets can be used, directly or indirectly, to put a dollar value on the anthropocentric instrumental value of the resource. The same approach is commonly used for exhaustible renewable resources, such as fish, shellfish, or timber, all of which are bought and sold in well-established markets.

Nature also contributes to the generation of goods and services valued by people which are not bought and sold in well-established economic markets. Familiar examples include many types of recreational activities including birdwatching, and noncommercial hunting, fishing, hiking, or camping trips. The quantity and quality of these recreational activities depend heavily upon natural resources. Fish and wildlife, for example, have anthropocentric instrumental values

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as "inputs" into the household "production" or generation of fishing, hunting, and birdwatching trips (Bockstael and McConnell 1983). How can these instrumental values be quantified in dollar terms?

A commonly applied method for measuring the economic value of natural resources as contributors to the quantity and quality of recreational activities is the travel cost method (TCM). The TCM is an economic valuation technique which uses travel expenditures as a proxy for the price of a recreational activity such as a fishing or birdwatching trip. Economists combine this price proxy with data on the quantity of trips taken by an individual or group, socioeconomic characteristics of an individual or group, and characteristics of the trip to estimate travel cost demand functions. These demand functions can be applied to estimate the economic value of trip characteristics such as number of fish caught on a fishing trip and the number of birds sighted on a birdwatching trip (Freeman 1993; Smith 1981; Ward and Loomis 1986).

An alternative to the TCM for measuring the anthropocentric instrumental value of natural resources as contributors to the quantity and quality of recreational activities is the contingent valuation method (CVM). The CVM involves surveys in which respondents are asked directly to state their preferences with respect to the provision and/or pricing of goods and services. In the case of recreational activities, survey participants may be asked to state if they would be willing to pay increased fishing license fees contingent upon an increase in catch rates, or increased park access fees contingent upon increased opportunities to view and photograph wildlife. Responses to these types of questions are econometrically analyzed to estimate the economic value of natural resources as contributors to the quantity and quality of recreational activities (Bergstrom et al. 1990; Bishop and Heberlein 1990; Freeman 1993; Mitchell and Carson 1989).

The contribution of natural resources to the quantity and quality of recreational activities experienced by an individual or group is an example of an *active use value.* Active use value, as the name suggests, refers to the instrumental value of natural resources derived from the active use of a resource (Bergstrom and Loomis 1998). Examples of active use values associated with recreational activities include the value of catching fish on a recreational fishing trip and the value of sighting birds on a recreational birdwatching trip. Active use values derived from natural resources are not limited to recreational activities. For example, the contribution of air and water resources to human health is another type of active use value associated with elements of God's creation. Active use values derived from the contribution of natural resources to human health can be valued using the CVM.

Another valuation technique which has been employed to quantify active use values derived from the contribution of natural resources to human health is the defensive expenditure technique. Suppose that pollutants in a household's water supply increase the risk of illness resulting from drinking the water. To avoid this risk, the household may increase expenditures on bottled water or home water filters. These increased expenditures can be used by economists to estimate the economic value of clean water from natural sources (Freeman 1993).

In addition to active use values, nature contributes to *passive use values.* Passive use values, as the name suggests, involve passive rather than active use of natural resources, including various forms of aesthetic values (Bergstrom and Reiling 1997). Aesthetic values associated with God's natural creation are instrumental values derived from the sensory (visual, aural, or olfactory) satisfaction people obtain from nature. Aesthetic values in the form of passive use values can be valued using either CVM or hedonic pricing methods.

The most common form of hedonic

pricing is the property value method, in which differential prices paid for real estate are used indirectly to estimate the aesthetic value of natural resources. For example, the higher price paid for residential property with scenic views, holding all other determinants of property value constant, can be used to infer the economic value associated with the instrumental value of natural resources as a source of visual satisfaction (Freeman 1993; Palmquist 1984).

Passive use values also include economic existence values, defined as the economic value of the satisfaction people obtain simply from knowing of the continued existence of an object, independent of current or expected future use of the object (Bergstrom and Reiling 1997; Randall and Stoll 1983). For example, even if a person never expects to visit Kodiak Island in Alaska and observe the giant Kodiak brown bears, merely thinking about and reflecting upon the continued existence of these bears in Alaska may produce feelings of satisfaction. Contributions to private or public organizations for the purpose of preserving the existence of a natural resource may be used to estimate economic existence value. Previous empirical studies attempting to measure economic existence value have relied almost exclusively on the CVM as a valuation technique (Boyle and Bishop 1987; Walsh, Loomis and Gillman 1984; van Kooten 1995).

The Human Relations Behind Economic Valuation

Economic values, whether based on market or nonmarket methods, arise through some combination of individuals' preferences, endowments, and production technologies. All are in part social constructions, so valuation is a function of human relations. Both "economics" and "ecology" derive from the Greek *oikos*, for household. It is the relationships of the biophysical-human-spiritual "household," both among humans and between us and the rest of creation, that lie at the heart of environmental valuation, management, and policy issues (Daly and Cobb 1989; DeVries 1998; Gottfried 1995). These relations are of foundational relevance to Christians because the core of Christian teaching about worldly matters, including the natural environment, is the transcendent worth of God's creation. Respect for the God-given dignity of all and for the unity of all in the One Living God is central to Christian ethics and theology, and to the economics of creation.

Many environmental controversies can be understood as fundamentally distributional questions about the allocation of use rights over natural resources among individuals, intra- or inter-generationally, or between humans and other species. These normative questions of distributive justice (what is the "right" share for the poor or for otherkind?) and procedural justice (what is the "right" means for determining resource allocations?) have long engaged many economists, perhaps especially Christian economists.

The Environment and Intragenerational Human Relations

The assignment of rights to use the natural resources God freely gives to humanity's care lies at the heart of most issues in ERE economics. Property rights define resource endowments and therefore access to the goods and services of nature and, derivatively, their economic valuation. The God-givenness of nature creates the classic property rights questions that underpin theories of appropriate individual welfare change measures, externalities and market failure, public resource management and environmental regulation, economic development, time discounting and several other topics in the ERE economics field.

Appropriate Measures of Individual Welfare Change

When applying the economic valuation concepts and techniques discussed in the previous section to natural resource and environmental goods and services, an issue that must be addressed explicitly or implicitly is whether the appropriate

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measure of individual welfare change is willingness-to-pay (WTP) or willingness-to-accept (WTA) compensation. Consider the case of environmental degradation by toxic chemical contamination of groundwater. If groundwater users have rights to the initial uncontaminated groundwater quality level, WTA for contamination is the theoretically appropriate welfare change measure. If groundwater users do not have rights to the initial uncontaminated groundwater quality level, WTP to prevent contamination or restore the groundwater to its initial quality is the theoretically appropriate welfare change measure (Freeman 1993).

Property rights to natural resource and environmental goods and services are often ambiguous. For example, pollution of the world's oceans from various sources is of increasing concern to scientists and government leaders. But since oceans outside of international political boundaries are essentially open-access resources, there are ill-defined property rights over open sea water quality.

The general implication of the Christian view of nature and its services as gifts from God, however, is that people have God-endowed rights to an undegraded environment, regardless of the incompleteness of legal specifications by human institutions. In many nations, secular laws endow the general public with legal rights to an undegraded environment. In the U.S., for example, the Comprehensive Environmental Response, Compensation, and Liability Act endows the general public with rights to territorial waters free from oil spills. When people hold explicit or implict rights to an initial, undegraded environment, the appropriate measure of individual welfare change associated with any type of environmental degradation is WTA. Even when it is the theoretically appropriate welfare measure, WTA is rarely employed empirically. The primary problem is that economists have yet to develop what the profession generally accepts as accurate and reliable techniques for measuring WTA. As a result, WTP is the preferred empirical welfare change measure for both increments and decrements in natural resource and environmental goods and services, even though it is theoretically less appropriate than WTA (Arrow et al. 1993; Freeman 1993).

Externalities and Market Failure

The environmental economics field grew out of the market failure-centered theories of externalities and environmental regulation (Ayres and Kneese 1969; Maler 1974; Pigou 1920; see also Cropper and Oates 1992 for an excellent review). As is well known from introductory economics, when individuals' behavior affects others' welfare (i.e., in the presence of externalities), the divergence between private and social benefits and costs leads to Pareto inefficient allocations that create a *prima facie* case for regulation. Of course, as Coase (1960) pointed out, in a world of zero transactions costs, completely specified property rights, and no strategic behavior, no interventions would be necessary because all affected parties would freely transact so as to resolve the externality problem. That most ERE economists deem the Coasian solution irrelevant is a strong implicit statement about the considerable transactions costs, incomplete rights specifications, and strategic or free riding behavior surrounding most large-scale externality issues, such as ozone layer degradation, biodiversity loss, or air or water pollution (Dixit and Olson 1997).

The point nonetheless remains, and has become increasingly emphasized in the ERE literature, that property rights are central to the functioning of markets in natural resources and the resolution of the market distortions externalities represent. Property rights are often incompletely defined and ineffectively enforced when the transactions costs of doing so are high or to do so would threaten powerful agents. As a crude rule of thumb, transactions costs increase exponentially with spatial and temporal distance. Thus, relatively local, current issues like effluent discharge into a watershed, solid waste disposal, or management of nonmigratory

wildlife often lend themselves well to market-based solutions predicated on the clear declaration of private property rights, such as tradable discharge or water use permits, or game cropping. But in the absence of complete forward markets and international contract law, markets may be less well suited to the resolution of externalities that are more global or intergenerational, such as climate change fostered by CO_2 emissions, tropical deforestation and biodiversity loss, or that involve migratory resources like ocean fisheries, waterfowl, or acid rain.

Resource Management and Environmental Regulation

Market failure problems stemming from externalities and other sources often lead to calls for more public management of nature and its services. It must be pointed out that environmental degradation has resulted from government failure as well as from market failure (Anderson and Hill 1995, 1996; Barrett 1996, 1998b; Binswanger 1991; Deacon 1994; Hill 1992, 1994). This can occur through any of several channels, including distorted prices (including interest rates that influence intertemporal choices), ineffective enforcement of the rule of law, and corruption. Incomplete specification of property rights is perhaps states' most common error of omission.

Garret Hardin's (1968) classic "tragedy of the commons" highlighted how open access resources commonly suffer overexploitation unless protected. Such protection can be direct, e.g., through the gazetting of parks or the specification and enforcement of private property rights (Anderson and Hill 1995, 1996), or indirect, e.g., through labor market initiatives to absorb surplus time that might otherwise be spent exploiting open access forests or wildlife (Barrett 1998a; Barrett and Arcese 1998).

While the industrial countries have developed resource tenurial institutions founded on private property, most of the world's natural resources are subject to common property regimes. Much recent work across the social sciences has emphasized the elaborate but often effective systems of rules and strategies that underpin common property regimes (Baland and Platteau 1996; Bromley 1991; Dasgupta 1993; Ostrom 1990). Nonetheless common property is often mistaken for open access resources by analysts and policymakers accustomed to traditions of private property. The crucial distinction is that common property regimes are governed by well-known access rules among a clearly-defined user group (Baland and Platteau 1996; Ciriacy-Wanstrup and Bishop 1975; Ostrom 1990).

Common property regimes may be more in keeping with the communitarian traditions of Judeo-Christian ethics than are western notions of private property, as perhaps best captured by fee simple tenure over land. Since the patristic period the Christian churches have affirmed that misuse of the world's resources "betrays the gift of creation since whatever belongs to God belongs to all" (NCCB 1986, p. 19). Private rights in property are, according to Scripture and the teachings of the Church, encumbered by social responsibilities to the community. The Biblical stewardship notion thereby differs in potentially nontrivial ways from traditional Lockean property rights, which include rights to disposal and destruction, and especially from modern institutional arrangements like limited liability (Barrett 1996, 1998b; Hay 1989). Moreover, adoption of a stewardship ethic has nontrivial implications for production and preservation practices, as most commonly recognized in multiple objective modeling in agricultural and ERE economics (van Kooten et al. 1990; van Kooten and Schmitz 1992).

But while common property regimes have proved quite effective in managing many local resources and seem to adhere to the communitarian spirit of both Scripture and modern Church teaching, global commons like ocean fisheries and the atmosphere have proved difficult to manage collectively, yet do not necessarily lend themselves well to market-based solutions founded on private property

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rights. The design of effective international agreements to protect the atmosphere and hydrosphere is an exceptionally active and important area of research in which there remains considerable room for progress.

Given ERE economists' skepticism about the prospects for resolving all environmental problems through specification and enforcement of property rights, much of the literature concentrates on exploration of the conditions guiding the optimal choice among regulatory policy instruments affecting incentives to pollute: Pigouvian effluent taxes, subsidies for clean technologies, and tradable pollution/use permits. Note that attention is focused almost entirely on changing polluters' incentives, and not on compensating the victims of externalities. This stems from the familiar result in the externalities literature that private defensive expenditures will generally be Pareto efficient, so any distortionary intervention on behalf of the victims of externalities will be inefficient (Cropper and Oates 1992).

While taxes were the original solution proposed by Pigou (1920) to the externalities problem, and while Baumol and Oates (1971) showed charges will generate similar pollution reduction at lower abatement cost than will standards, effluent charges are nonetheless used considerably less frequently than are regulatory standards. Why this is so remains a key riddle in environmental economics. Part of the reason is likely the difficulty of estimating either a social damage cost function or a firm or industry's abatement cost schedule *ex ante*. Political economy pressures from powerful industrial interest groups are likely also partly accountable. Another explanation arises from the uncertainty of the damages pollution might bring. Unlike choice under pure (quantifiable) risk, uncertainty appears to—and should, by Arrow-Hurwicz Theorem—tend regulatory decision makers toward maximin solutions rather than expected welfare maximization (Woodward and Bishop 1997). That is, catastrophic vulnerability should be limited by choosing the option offering the least damaging worst case.

Environmental regulation is weak in most of the world, as one notices quickly in most Third World cities. Yet there are firms even in formally unregulated settings that could satisfy stringent emissions standards. One possible explanation for this is that firm owners and managers internalize environmental ethics in their own decision-making, but such a reason points to a need for multi-objective modeling of firm behavior, a route the profession has largely eschewed. An alternative, interesting recent strand of the environmental economics literature considers the process by which communities might informally regulate industrial pollution through strategic relations with firms (Afsah et al. 1996; Pargal and Wheeler 1996). As in all such game theoretic equilibria, in the implicit (and sometimes explicit) bargaining between firms and communities, relative power matters. Weak communities populated with poorer, less educated persons tend to suffer greater exposure to pollution, thereby providing an economic explanation for the complaint at the heart of the environmental justice movement, that the poor disproportionately bear the burden of society's waste, with potentially serious consequences on community health and wealth (Bryant 1995; UCCRJ 1987; Wheeler 1996).

Economic Development and the Environment

More than two-thirds of humanity lives on less than $3/day and about two-thirds of those poor live in rural areas, where they are difficult to see. Because the poor, especially the rural poor, are disproportionately dependent on natural capital in their daily struggles for survival, environmental protection is central to fighting poverty and food insecurity (Barrett 1996, 1998b; Barrett and Arcese 1995; Barrett and Grizzle 1998a,b; DeVries 1998; Reardon and Vosti 1995; Vosti and Reardon 1997; World Bank 1992). Thus the poor tend to be among both the primary victims and the leading agents of environmental

damage worldwide, particularly due to use of inferior technologies (e.g., wood fuels, swidden agriculture) and unsustainably intensive use of exhaustible renewal resources (e.g., forests, wildlife, soils).

Poverty and environmental degradation are often twin symptoms of government and market failure. Nonetheless, the strength of the connection between poverty and the environment is commonly and easily underappreciated, even among the reasonably well-informed. Thankfully, this relationship has drawn rapidly increasing attention this decade, particularly since the World Bank devoted its *World Development Report 1992* to the poverty-environment nexus (under the direction of Association member Andrew Steer).

One particularly promising line of research asks whether an alternative measure of poverty might be more appropriate to addressing the need to relieve both human and environmental suffering (Reardon and Vosti 1995, Vosti and Reardon 1997). Households with incomes above conventional poverty lines may nonetheless have insufficient resources to invest in maintaining or enhancing the natural resource base on which they depend for current income. That is, they depreciate the natural capital over which they have some claim, although standard survey and analytical methods do not pick up this phenomena. This is the microeconomic analogue to the problematic design of the UN system of national accounts (discussed in the next section). This line of inquiry also emphasizes the complex, state-conditional relationship between environment and poverty, leading to a richer understanding of the conditioning variables that affect this nexus and, derivatively, of appropriate policy interventions (Reardon 1995; Reardon et al. 1997).

The causal relation between poverty alleviation and environmental protection is bidirectional. Not only does improvement in the natural resource base facilitate improved livelihoods among the poor, but decreased poverty and food insecurity benefits the natural environment that provides quasi-insurance to the destitute and desperate. Contrary to the impression left by much of the environmental literature in the industrial countries, environmental crisis is not uniquely attributable to advanced industrial or post-industrial economic systems. The manifold ecological crises of the former Soviet Union, the severe air and water pollution problems of many Third World cities, and rapid deforestation, desertification and biodiversity loss in poor rural areas around the world highlight not only the multidimensionality of environmental problems, but also the inextricability of some of these problems from issues of income growth and poverty alleviation (Barrett 1996; Barrett and Grizzle 1998a,b; Hill 1992).

Many recent authors have emphasized the role of employment creation, improved technologies, etc. in conservation efforts (Barrett 1996, 1998a; Barrett and Arcese 1995, 1998; Daly and Cobb 1989; Ledec and Goodland 1990; Serageldin and Steer 1994; van Kooten et al. 1997; World Bank 1992). Similarly, the increasingly popular case for substantial international transfers tied to poverty alleviation and environmental conservation follows from the inextricability of poverty from renewable resource overexploitation and the absence of a supernational authority capable of levying and enforcing either environmental taxes or regulations on poor countries. The optimal policy for resolving transboundary environmental externalities seems to be subsidization of "cleaner" production technologies and consumption patterns (Barrett 1996, 1998b; Costanza et al. 1997; WCED 1987).

International Trade and the Environment

Just as environmental issues have begun to permeate the literature on international development, so too have they established a beachhead in the field of international trade. Dean (1997) argues that the preponderance of the evidence, both empirical and theoretical, is that

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free(r) trade generally helps the poor and the environment. For example, trade barriers (both tariff and nontariff) appear to raise the toxic intensity of LDC manufacturing (Hettige et al. 1992). Relatedly, and contrary to early environmentalists' concerns, it appears that regulatory compliance costs are small enough that international variation in environmental protection measures has no significant effect on international trade patterns, or, derivatively, on either "industrial flight" from countries with stricter environmental standards or on the creation of "pollution havens" in (generally poor) countries with lax standards (Robison 1985; Tobey 1990).

Nonetheless, much recent theoretical literature has focused on mechanisms by which expanded international trade can stress the global commons, intensifying both local and transboundary environmental problems (Chichilnisky 1994; Copeland and Taylor 1994, 1995, 1997). Also, of increasing concern to many environmentalists is the nondiscrimination clause of the World Trade Organization (WTO), and its predecessor, the GATT. WTO members are not permitted to discriminate between otherwise identical products made using different methods. Hence the GATT dispute resolution body's finding in favor of Mexico in 1991 when it protested the United States' prohibition of imports of tuna caught using netting processes that killed too many dolphins. This decision and the subsequent and growing controversy surrounding the trade-environment nexus raises new, important questions about the economics of nontariff, technical barriers to trade. If an imperfectly observable production process (e.g., dolphin-safe tuna fishing, organic farming) matters to consumers, then regulatory barriers that convey information consumers value can yield potential Pareto improvements over free trade (Thilmany and Barrett 1997), but can also exacerbate the very incentives that induce environmentally damaging production processes (Bulte and van Kooten 1996; Dean 1995). Economists are only just starting to tackle these issues carefully, and it is likely that we will find that the both analytical and empirical results will prove sensitive to researchers' choice among many environmental problems and trade policy instruments, and to their controls for simultaneous changes in the composition, direction, and volume of trade.

The Environment and Intergenerational Human Relations

Much current activity on economics and the natural environment has been spurred by the 1987 report of the World Commission on Environment and Development (the Brundtland Commission) and by the 1992 United Nations Conference on Environment and Development, held in Rio de Janeiro. According to the WCED (1987, p. 43), sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition highlights the intergenerational ethical questions at the core of much contemporary economic research into sustainable development. Indeed, most current basic economic research on sustainable development has focused heavily on issues of intergenerational equity (Asheim 1988, 1991; Hartwick 1977; Howarth 1992, 1995; Solow 1974).

The community of ecological economists are especially active in the many dimensions of this topic, emphasizing, first, that the embeddedness of the economic system in a finite global ecosystem imposes natural limits to growth and, second, that the dynamics of economic and ecological systems are interdependent, which implies that current choices can have major consequences for future opportunity sets (Costanza et al. 1997; Daly and Cobb 1989; Daly 1996; Goodland et al. 1991; Gottfried 1995; Perrings 1995). The scale of human economic activity has an impact on the natural ecosystem from which it both draws resources for direct or indirect consumption and deposits its wastes. Hence the focus of most contemporary writing in ecological economics on

the anthropogenic effects of human activity—manifest in global warming, desertification, tropical deforestation and biodiversity loss, ozone shield rupture, pollution, etc.—on prospective methods to model dynamic human-environment interactions accurately, and on feasible, effective interventions to stem human-induced environmental degradation. Because of the complex and highly nonlinear spatial and temporal interactions between ecological and economic phenomena, the modeling of dynamic anthropogenic effects on the environment has become a key topic in the field, but one showing relatively little progress to date (Common and Perrings 1992; Perrings 1987, 1995). Scientists are increasingly finding multiple ecosystem equilibria that may be stable when subject to small shocks but unstable when subject to large ones (e.g., asteroid impacts that may have killed off the dinosaurs, nuclear winter). There are thus strong emerging links between ecological economics and the more general study of nonlinear dynamics.

Sustainable Development

The dispute over whether economic growth provides a useful proxy for development has long permeated the literature on international development. The rapidly growing literature on 'sustainable development,' particularly the writing of ecological economists, emphasizes the need to redirect attention away from existing United Nations system of national accounts that count depreciation of manmade capital but not of natural exhaustible capital, yet treat expenditures made to defend or clean up the environment as productive (Costanza et al. 1997; Daly 1996; Daly and Cobb 1989; Goodland et al. 1991; Lutz 1993). As a result, much recent effort has been directed toward designing new national accounting systems that might distinguish better between growth in the throughput of material resources and improvements in efficiency (Daly 1996; Daly and Cobb 1989; World Bank 1997). The United Nations has committed to designing and promoting the use of "green" national accounts. Failure to account for natural resource degradation can lead to the inadvertent impoverishment of future generations if technological advance in the efficient use of and substitution for natural resources and natural sinks for waste does not at least keep pace. More generally, ERE economists have been trying to redirect attention away from "growth," as traditionally measured, and toward "efficiency improvements" that permit enhanced material well-being with nonincreasing throughput of exhaustible natural resources (Arrow et al. 1995; Daly 1996).

Tensions exist between those concerned for the environmental sustainability of creation and those concerned for the relief of endemic human suffering in much of the world. Christian writers in the field, in particular, have aimed at reconciling these objectives (Barrett 1996; Barrett and Grizzle 1998a,b; Boulding 1985; Cobb 1992; Goodland et al. 1991), recognizing that significant improvement in the lives of people lacking access to necessary food, water, clothing and shelter will require increased reliance on both natural resources and natural sinks by those subpopulations.

This naturally focuses attention on the perceived excess consumption of the wealthier subpopulations, particularly those concentrated in Europe and North America. Most religions, not only Christianity, emphasize the virtue of frugality and the sin of gluttony. Christian environmental ethicists have therefore emphasized the risks taken on by a culture driven by material consumption and growth (Nash 1991). While half the world's population suffers significant material want, there is widespread belief that the wealthiest ten percent of the globe consumes far too much, creating waste disposal and resource extraction problems that may imperil future generations and further injure today's poor. Frank (1997) sees excess material consumption as largely a product of "positional externalities," in which individuals' satisfaction

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depends significantly on relative position in a community. Frank advocates progressive consumption taxes in recognition that positional externalities create suboptimal resource allocations, in particular excessive material consumption. While not writing within the ERE literature, this is consistent with much current writing directly on the environment (Daly and Cobb 1989; Gottfried 1995). For example, Goodland (1997) argues for progressive food conversion efficiency taxes as a means to enhance environmental sustainability in the agriculture sector by inducing people to eat lower down on the food chain, where there is far greater efficiency of conversion of plant material into human energy. The basic logic is similar to that of fuel inefficiency taxes on vehicles: use taxes to internalize the inverse relationship between energy efficiency and the magnitude of the negative externalities associated with production (in this case of food, instead of transport).

Discounting

Economists generally assume benefits or costs incurred sooner matter more than those incurred later, *ceteris paribus*. This derives from consumers' intertemporal preferences and from the productivity of capital, which together yield interest rates. It is therefore customary to discount future benefits and costs by the prevailing interest rate to generate the discounted net present value of a project. Discount rates thereby affect intertemporal management decisions, as reflected in the massive resource economics literature.

Although the logic behind discounting is familiar, it has nonetheless been subject to considerable criticism that parallels, in some ways, traditional Christian (and Islamic) critiques of usury. Applied to large-scale environmental issues, time discounting effectively treats as negligible prospective costs that are more than about half a century away, no matter how potentially catastrophic (e.g., climate change, toxic waste storage, biodiversity loss). Implicit in the notion of discounting is an assumption of perfect substitutability between resources within and across generations. So, for example, it is implicitly assumed that the higher standard of living enjoyed today, and transmitted into the future, thanks to large-scale burning of fossil fuels can substitute for the potential effects of global warming due to excessive carbon emissions. Discounting's implicit bias against future generations seems at least superficially inconsistent with notions of sustainability predicated on intergenerational equity. It also seems to some to elevate impatience and material consumption to a higher-than-deserved status (Page 1977).

Temporal Uncertainty

A fundamental criticism of discounting arises from the ubiquitousness of temporal uncertainty. Since uncertainty is generally increasing in time horizons, the uncertainty over future costs and benefits is generally greater than that surrounding current ones. To conduct cost-benefit analysis purely on the basis of expected values is to ignore both the temporal accrual of information that creates quasi-option value (QOV) and the possibility of risk aversion. Arrow and Fisher (1974) first showed that temporal uncertainty combined with (at least partial) irreversibility of a development project creates added value, which they labeled QOV, to postponing development. QOV captures the value of preserving options to future use once better information about alternatives becomes available.

Rejection of conventional cost-benefit analytical techniques finds its greatest expression in the literatures on safe minimum standards (SMS) and the precautionary principle (Bishop 1978; Ciriacy-Wanstrup 1952, 1961; Perrings 1991; Woodward and Bishop 1997). The core notion is to safeguard large-scale ecological processes of unknown resilience, in other words to guard against irreversible catastrophes unless the cost of doing so is prohibitively large. The SMS approach emphasizes that (i) the benefits (costs) of preservation (development) are generally unknown even to the modest

level of being characterizable by a probability mass function, that (ii) in the presence of potentially catastrophic irreversibilities, a maximin (maximize the minimum outcome) rule should be followed, and, from (i) and (ii), that preservation should be the default unless it can be demonstrated that the preservation entails prohibitively large social costs (the foregone benefits of development) that are equitably distributed across generations. The precautionary principle and SMS approach can be understood, therefore, as choice rules under uncertainty as opposed to risk.

Human Population Growth

The scale of human impact on the natural environment is the simple product of population and per capita resource use and waste disposal. So environmental scholars often emphasize the contribution of human population growth to degradation of creation. Analogous (and closely related) to the poverty-environment nexus, there appears to be some bidirectional causality in the population growth-environmental degradation relationship (Dasgupta 1993). Christian writers appear divided in the emphasis they place on controlling human population growth. Poverty stimulates population growth and more than 90 percent of the world's population growth occurs in low-income countries. So some writers argue that population problems are endogenous symptoms of the vicious cycle linking poverty and environmental degradation, and therefore that attention should be focused at the core challenge of poverty alleviation and on changing social structures that give rise to endemic poverty and excessive population growth, moreso than on population policy *per se* (Barrett 1996; Clay et al. 1996). Others argue that a large portion of births worldwide are unplanned and unwanted, and that meeting considerable unmet demand for family planning services is crucial to slowing or stopping environmental degradation (Goodland et al. 1991; De Vries 1998).

The claim that population growth increases the scale of adverse anthropogenic effects on nature has also been subject to challenge, for it assumes static technologies. Boserup (1965) first proposed that increased population density induces labor-using innovation and intensification that may be helpful to environmental conservation efforts. Emerging empirical micro- and macro-scale evidence seems to support this claim (Patel et al. 1995; Selden and Song 1994; Tiffen et al. 1994; Turner et al. 1993; Vosti and Reardon 1997; World Bank 1992).

Some Closing Thoughts

Questions surrounding the relationship between humanity and the rest of God's creation loom large in contemporary society. These questions have drawn considerable attention over the past quarter century from economists, both secular and Christian, drawn by both the importance of the topic and the significant technical challenges therein, such as modeling human-ecology relations or valuing nonmarketed natural resources. The Christian belief in the unity of all creation in the One Living God, with special stewardship rights and responsibilities vested in humans created in God's image, may endow technically-skilled Christian economists with a comparative advantage in tackling the important questions involved in the EREE field with appropriate holism and without sacrificing necessary technical rigor. We have tried in this brief survey to show some of the many ways in which members of this Association have already made important contributions to this area and to highlight a few areas ripe for further research.

Many of the issues central to ERE economics cut to the core of economic theory and methodology. How do we value goods and services not transacted in competitive markets? What is the role of markets and atomistic institutions in the efficient and equitable allocation of resources? What allocation rules should guide public policy? What is the best use of markets and states to reduce poverty and improve the human (or biosphere's)

Many of the issues central to ERE economics cut to the core of economic theory and methodology.

condition? What motivates human behavior and how might motivations influence economic performance? Economists are increasingly acknowledging that beliefs and community institutions condition behavior and therefore that engendering a widespread sense of responsibility for the whole of creation is central to the task of improving human welfare (Barrett 1996, 1998b; Daly and Cobb 1989; Frank 1997; Nash 1991; Pargal and Wheeler 1996; Serageldin and Barrett 1996).

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