CHAPTER

3

Ends, Means, and Policy

Ends and Means—A Practical Dualism

Ecological economics has at least as much in common with standard economics as it has differences. One important common feature is the basic definition of economics as the study of the allocation of scarce means among competing ends. There are disagreements about what is scarce and what is not, what are appropriate mechanisms for allocating different resources (means), and about how we rank competing ends in order of importance—but there is no dispute that using means efficiently in the service of ends is the subject matter of economics. Using means in the service of ends implies policy. Alternatively, policy implies knowledge of ends and means. Economics, especially ecological economics, is inescapably about policy, although the rarefied levels of abstraction sometimes reached by economists may lead us to think otherwise.

If economics is the study of the allocation of scarce means in the service of competing ends, we have to think rather deeply about the nature of ends and means. Also, policy presupposes knowledge of two kinds: of possibility and purpose; of means and ends. Possibility reflects how the world works. In addition to keeping us from wasting time and money on impossibilities, this kind of knowledge gives us information about tradeoffs among real alternatives. Purpose reflects desirability, our ranking of ends, our criteria for distinguishing better from worse states of the world. It does not help much to know how the world works if we cannot distinguish better from worse states of the world. Nor is it useful to pursue a better state of the world that happens to be impossible. Without both kinds of knowledge, policy discussion is meaningless.

To relate this to economic policy, we need to consider two questions. First, in the realm of possibility, the question is: What are the means at our

disposal? Of what does our ultimate means consist? By "ultimate means" we mean a common denominator of possibility or usefulness that we can only use up and not produce, for which we are totally dependent on the natural environment. Second, what ultimately is the end or highest purpose in whose service we should employ these means? These are very large questions, and we cannot answer them completely, especially the latter. But it is essential to raise the questions. There are some things, however, that we say by way of partial answers, and it is important to say them.

Means

Ultimate means, the common denominator of all usefulness, consist of low-entropy matter-energy.[1] Low-entropy matter-energy is the physical coordinate of usefulness; the basic necessity that humans must use up but cannot create, and for which the human economy is totally dependent on nature to supply. Entropy is the qualitative physical difference that distinguishes useful resources from an equal quantity of useless waste. We do not use up matter and energy *per se* (First Law of Thermodynamics), but we do irrevocably use up the quality of usefulness as we transform matter and energy to achieve our purposes (Second Law of Thermodynamics). All technological transformations require a before and after, a gradient or metabolic flow from concentrated source to dispersed sink, from high to low temperature.[2] The capacity for entropic transformations of matter-energy to be useful is therefore reduced both by the emptying of finite sources and by the filling up of finite sinks. If there were no entropic gradient between source and sink, the environment would be incapable of serving our purposes or even sustaining our lives. Technical knowledge helps us use low entropy more efficiently; it does not enable us to eliminate or reverse the direction of the metabolic flow.

Matter can of course be recycled from sink back to source by using more energy (and more material implements) to carry out the recycling. Energy can only be recycled by expending more energy to carry out the recycling than the amount recycled, so it is never economic to recycle energy—regardless of price. Recycling also requires material implements for collection, concentration, and transportation. The machines used to collect, concentrate, and transport will themselves wear out through a process of **entropic dissipation**—the gradual erosion and dispersion of their material components into the environment in a one-way flow of low entropy usefulness to high entropy waste. Any recycling process must be

[1]By matter-energy we mean just matter and energy, but with the recognition that they are convertible according to Einstein's famous formula, $E = mc^2$.

[2]For a scholarly development of this theme, see N. Georgescu-Roegen, *The Entropy Law and the Economic Process*, Cambridge, MA: Harvard University Press, 1971.

efficient enough to replace the material lost to this process. Nature's biogeochemical cycles powered by the sun can recycle matter to a high degree—some think 100%. But this only underlines our dependence on nature's services, since in the human economy we have no source equivalent to the sun, and our finite sinks fill up because we are incapable of anything near 100% materials recycling.

Information: The Ultimate Resource? There is a strong tendency to deny our dependence on nature to achieve our purposes. Among the more explicit denials is that from George Gilder:[3]

> *Gone is the view of a thermodynamic world economy, dominated by "natural resources" being turned to entropy and waste by human extraction and use. . . . The key fact of knowledge is that it is anti-entropic: it accumulates and compounds as it is used. . . . Conquering the microcosm, the mind transcends every entropic trap and overthrows matter itself.*

According to *The Economist*, George Gilder is "America's foremost technology prophet" whose recommendation can cause the share price of a company to increase by 50 percent the next day.[4] If Gilder is really that influential, it simply proves that stock prices are often based on erroneous information and irrational expectations. To cast further doubt on Gilder's Gnostic[5] prophecy, one need only recall the aphorisms of Nobel chemist Frederick Soddy: "No phosphorus, no thought"[6] and of Loren Eisley: "The human mind . . . burns by the power of a leaf." As Kenneth Boulding—one of the pioneers of ecological economics—pointed out, knowledge has to be imprinted on physical structures in the form of improbable arrangements of matter before it is effective in the economy. And low entropy is the quality of matter-energy that increases its capacity to receive and retain the improbable imprint of human knowledge. For example, to receive the imprint, a typical computer microelectronics plant producing 5000 wafers per day generates some 5 million liters of organic and aqueous solvent waste (i.e., high entropy) per year,[7] in addition to raw materials and

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[3]G. Gilder, *Microcosm: The Quantum Revolution in Economics and Technology*, New York: Simon & Schuster, 1989, p. 378. Similar views are expressed by the late Julian Simon in *The Ultimate Resource*, Princeton, NJ: Princeton University Press, 1981. Recently Peter Huber has continued the tradition in *Hard Green: Saving the Environment from the Environmentalists*, New York: Basic Books, 2000.

[4]March 25, 2000, p. 73.

[5]Gnosticism was an early Christian heresy teaching that salvation was available only to those who through esoteric spiritual knowledge could transcend matter, and who believed that Christ was noncorporeal; hence, any view that denigrates the material world and sees knowledge as an escape therefrom.

[6]Phosphorous is an essential component of chlorophyll, which is required for photosynthesis, which in turn is required for life, which is required for thought.

[7]J.M. Desimone, Practical Approaches to Green Solvents, *Science* 297 (5582) (2002).

energy used. With regard to retaining the imprint, recent estimates suggest that the information technology (IT) economy in the U.S. currently consumes 13% of the electricity we use as a nation, and this level is increasing rapidly.[8]

Furthermore, as important as knowledge is, it is misleading to say it grows by compounding accumulation. New dollars from compound interest paid into a bank account are not offset by any decline in old dollars, that is, the principal. Yet new knowledge often renders old knowledge obsolete, as we saw in our discussion of scientific revolutions and paradigm shifts. Do scientific theories of phlogiston[9] and the ether[10] still count as knowledge? And when knowledge becomes obsolete, the artifacts that embody that knowledge become obsolete as well. Again the IT economy is the best example. Experts estimate that 300 million personal computers, each containing 7–10 pounds of toxic metal, will end up in U.S. landfills over the next 5 years alone.[11] For every three computers that enter the market, two become obsolete. This is hardly antientropic. Physicists will not be surprised, because they have never found anything that is antientropic.

As E. J. Mishan noted, technological knowledge often unrolls the carpet of increased choice before us by the foot, while simultaneously rolling it up behind us by the yard.[12] Yes, knowledge develops and improves, but it does not grow exponentially like money compounding in the bank. Furthermore, new knowledge need not always reveal new possibilities for growth; it can also bring serious harm and reveal new limitations. The new knowledge of the fire-resisting properties of asbestos increased its usefulness; subsequent new knowledge of its carcinogenic properties reduced its usefulness. New knowledge can cut both ways. Finally, and most obviously, knowledge has to be actively learned and taught every generation—it cannot be passively bequeathed like an accumulating stock portfolio. When society invests little in the transfer of knowledge to the next generation, some of it is lost and its distribution often becomes more

[8]M.P. Mills, "Kyoto and the Internet: The Energy Implications of the Digital Economy," Testimony of Mark P. Mills, Science Advisor, The Greening Earth Society, Senior Fellow, The Competitive Enterprise Institute, President, Mills-McCarthy & Associates, before the Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs, U.S. House of Representatives, 2000.

[9]Phlogiston is a hypothetical substance formerly thought to be a volatile constituent of all combustible material, released as flame in combustion.

[10]Ether is an all-pervading, infinitely elastic, massless medium once thought to fill the upper regions of space, as air fills the lower regions. Its hypothetical existence avoided confronting the mystery of "action at a distance," later recognized in the concept of gravity.

[11]"Electronic Product Recovery and Recycling Baseline Report: Recycling of Selected Electronic Products in the United States," National Safety Council, May 1999.

[12] E. J. Mishan, *The Costs of Economic Growth*, New York: Praeger, 1967.

concentrated, contributing to the growing inequality in the distribution of income, as well as to a general dumbing-down of the future.

It is a gross prejudice to think that the future will always know more than the past. Every new generation is born totally ignorant, and just as we are always only one failed harvest away from starvation, we are also always only one failed generational transfer of knowledge away from darkest ignorance. Although it is true that today many people know many things that no one knew in the past, it is also true that large segments of the present generation are more ignorant than were large segments of past generations. The level of policy in a democracy cannot rise above the average level of understanding of the population. In a democracy, the distribution of knowledge is as important as the distribution of wealth.

Waste as a Resource? The common view among economists and many others is that waste is just a resource we have not yet learned to use, that nature supplies only the indestructible building blocks of elemental atoms, and that all the rest either is or can be done by humans. What counts to economists is value added by human labor and capital—that to which value is added is thought to be totally passive stuff, not even worthy of the name *natural resources*, as evidenced by Gilder's putting the term in quotation marks. Natural processes, in this view, do not add value to the elemental building blocks—and even if they did, manmade capital is thought to substitute for such natural services.

The brute facts remain, however, that we can only get so much energy from a lump of coal, we cannot burn the same lump twice, and the resulting ashes and heat scattered into nature's sinks really are polluting wastes and not just matter-energy of equally useful potential, if only we knew how to use it. Eroded topsoil washed to the sea and chlorofluorocarbons in the ozone layer are also polluting wastes on a human time scale, not just "resources out of place." No one denies the enormous importance of knowledge.[13] But this denigration of the importance of the physical world, and exclusive emphasis on knowledge as our ultimate resource, seems to be a modern version of Gnosticism. It appears to be religiously motivated by a denial of our creaturehood as part of the material world, by the belief that we have, or soon will have, transcended the world of material creation and entered an unlimited realm of esoteric knowledge, albeit technical now rather than spiritual. Thus, even in the discussion of means we are pushed out of the purely biophysical realm to

[13]For interesting discussions of the limitations of knowledge, see P. R. Ehrlich et al., Knowledge and the Environment, *Ecological Economics* 30:267–284 (1999) and M. H. Huesemann, Can Pollution Problems Be Effectively Solved by Environmental Science and Technology? An Analysis of Critical Limitations, *Ecological Economics* 37:271–287 (2001).

consider alternative religious philosophies, including most prominently the revival of the ancient Christian heresy of Gnosticism.

Ends

We argued earlier that there is such a thing as ultimate means, and that it is low-entropy matter-energy. Is there such a thing as an **ultimate end**, and if so, what is it? Following Aristotle, we think there are good reasons to believe that there must be an ultimate end, but it is far more difficult to say just what it is. In fact we will argue that, while we must be dogmatic about the existence of the ultimate end, we must be very humble and tolerant about our hazy and differing perceptions of what it looks like.

In an age of "pluralism," the first objection to the idea of ultimate end is that it is singular. Do we not have many "ultimate ends"? Clearly we have many ends, but just as clearly they conflict and we must choose among them. We rank ends. We prioritize. In setting priorities, in ranking things, something—only one thing—has to go in first place. That is our practical approximation to the ultimate end. What goes in second place is determined by how close it came to first place, and so on. Ethics is the problem of ranking plural ends or values. The ranking criterion, the holder of first place, is the ultimate end (or its operational approximation), which grounds our understanding of objective value—better and worse as real states of the world, not just subjective opinions.

We do not claim that the ethical ranking of plural ends is necessarily done abstractly, *a priori*. Often the struggle with concrete problems and policy dilemmas forces decisions, and the discipline of the concrete decision helps us implicitly rank ends whose ordering would have been too obscure in the abstract. Sometimes we have regrets and discover that our ranking really was not in accordance with a subsequently improved understanding of the ultimate end.

Neoclassical economists reduce value to the level of individual tastes or preferences, about which it is senseless to argue. But this apparent tolerance has some nasty consequences. Our point is that we must have a dogmatic belief in objective value, an objective hierarchy of ends ordered with reference to some concept of the ultimate end, however dimly we may perceive the latter. This sounds rather absolutist and intolerant to modern devotees of pluralism, but a little reflection will show that it is the very basis for tolerance. If A and B disagree regarding the hierarchy of values, and they believe that objective value does not exist, then there is nothing for either of them to appeal to in an effort to persuade the other. It is simply A's subjective values versus B's. B can vigorously assert her preferences and try to intimidate A into going along, but A will soon get wise to that. They are left to resort to physical combat or deception or manipulation, with no possibility of truly reasoning together in search of a clearer shared

vision of objective value, because, by assumption, the latter does not exist. Each knows his own subjective preferences better than the other, so no "values clarification" is needed. If the source of value is in one's own subjective preferences, then one does not really care about the other's preferences, except as they may serve as means to satisfying one's own. Any talk of tolerance becomes a sham, a mere strategy of manipulation, with no real openness to persuasion.[14]

Of course, we must also be wary of dogmatic belief in a too explicitly defined ultimate end, such as those offered by many fundamentalist religions.[15] In this case, again, there is no possibility of truly reasoning together to clarify a shared perception, because any questioning of revealed truth is heresy.

The Presuppositions of Policy

Ecological economics is committed to policy relevance. It is not just a logical game for autistic academicians. Because of our commitment to policy, we must ask: What are the necessary presuppositions for policy to make sense, to be worth discussing? We see two.

First, we must believe that there are real alternatives among which to choose. If there are no alternatives, if everything is determined, then it hardly makes sense to discuss policy—what will be, will be. If there are no options, then there is no responsibility, no need to think.

Second, even if there are real alternatives, policy dialogue would still make no sense unless there were a real criterion of value to use for choosing among the alternatives. Unless we can distinguish better from worse states of the world, it makes no sense to try to achieve one state of the world rather than another. If there is no value criterion, then there is no responsibility, no need to think.

In sum, serious policy must presuppose: (1) nondeterminism—that the world is not totally determined, that there is an element of freedom that offers us real alternatives; and (2) nonnihilism—that there is a real criterion of value to guide our choices, however vaguely we may perceive it.

The fact that many people engaged in discussing and making policy reject one or both of these presuppositions is, in A. N. Whitehead's term, "the lurking inconsistency," a contradiction at the basis of the modern worldview that enfeebles thought and renders action halfhearted. If we even halfway believe that purpose is an illusion foisted on us by our genes

[14]For a fuller exposition of this argument, see C. S. Lewis, *The Abolition of Man*, New York: Macmillan, 1947.

[15]Many economists seem to view "efficiency" and/or growth as the ultimate end and border on religiosity in their convictions. See Robert Nelson, *Economics as Religion*, University Park: Pennsylvania State University Press, 2002.

to somehow make us more efficient at procreation,[16] or that one state of the world is as good as another, then it is hard to get serious about real issues. And ecological economics must be serious about real issues. As Whitehead noted, "Scientists animated by the purpose of proving that they are purposeless constitute an interesting subject for study."[17]

Determinism and Relativism

The preceding section may seem pretty obvious and consistent with common sense. What is the point of stating the obvious? The point is that many members of the intelligentsia deny either nondeterminism, nonnihilism, or both, yet they want to engage in a policy dialogue. It is not just that we disagree on exactly what our alternatives are in a particular instance, or about what our value criterion implies for a concrete case—that's part of the reasonable policy dialogue. The point is that determinists who deny the effective existence of alternatives, and nihilists or relativists who deny the existence of a value criterion beyond the level of subjective personal tastes, have no logical basis for engaging in policy dialogue—and yet they do! We cordially and respectfully invite them to remember and reflect deeply upon their option of remaining silent—at least about policy.[18]

One may well agree with the logic of our position—that policy rules out determinism and nihilism—but argue that there are so few real determinists and nihilists around that in effect we are kicking at an open door, or attacking a straw man. We hope this is true. However, one leading biologist, Paul R. Ehrlich, who has contributed much to ecological economics, recently wrote a book with this stated purpose:[19] "to give an evolutionist's antidote to the extreme hereditary determinism that infests much of the current discussion of human behavior—the idea that we are somehow simply captives of tiny, self-copying entities called genes" (p. x). In other words, Ehrlich felt that the influence of the hard-line determinists is sufficiently toxic to require a 500-page antidote, even if a rather mild and general one.

A stronger and more specific antidote was thought necessary by Wen-

[16]As asserted in E. O. Wilson's *Consilience* (New York: Knopf, 1998) and R. Dawkins' *The Blind Watchmaker* (New York: Norton, 1996).

[17]A. Whitehead, *The Function of Reason*, Princeton, NJ: Princeton University Press, 1929, p. 12.

[18]In the sciences, these are hard-line neo-Darwinists and sociobiologists; in the humanities, postmodern deconstructionists; in theology, hard-line Calvinist believers in predestination; and in the social sciences, some evolutionary psychologists, and so-called "value-free" economists who reduce value to subjective individual tastes, any one of which is as good as another.

[19]P. R. Ehrlich, *Human Natures: Genes, Cultures, and the Human Prospect*, Washington, DC: Island Press, 2000.

dell Berry, who took particular aim at the influential writings of Edward O. Wilson, especially his recent book *Consilience*. Berry deserves to be quoted at length: [20]

> *A theoretical materialism as strictly principled as Mr. Wilson's is inescapably deterministic. We and our works and acts, he holds, are determined by our genes, which are determined by the laws of biology, which are determined ultimately by the laws of physics. He sees that this directly contradicts the idea of free will, which even as a scientist he seems unwilling to give up, and which as a conservationist he cannot afford to give up. He deals with this dilemma oddly and inconsistently.*
>
> *First, he says that we have, and need, "the illusion of free will," which, he says further, is "biologically adaptive." I have read his sentences several times, hoping to find that I have misunderstood them, but I am afraid that I understand them. He is saying that there is an evolutionary advantage in illusion. The proposition that our ancestors survived because they were foolish enough to believe an illusion is certainly optimistic, but it does not seem very probable. And what are we to think of a materialism that can be used to validate an illusion? Mr. Wilson nevertheless insists upon his point; in another place he speaks of "self-deception" as granting to our species the "adaptive edge." Later, in discussing the need for conservation, Mr. Wilson affirms the Enlightenment belief that we can "choose wisely." How a wise choice can be made on the basis of an illusory freedom of the will is impossible to conceive, and Mr. Wilson wisely chooses not to try to conceive it. (p. 26)*

We have learned from personal conversation with Wilson that he considers the question of how one squares scientific determinism with purposeful policy to be "the mother of all questions." Mutual humility in the face of mystery and paradox is more easily expressed, and understood, in friendly conversation over wine and dinner than in dry academic print. No one can, in practice, live by the creeds of determinism or nihilism. In this sense, no one takes these creeds seriously, not even the advocates themselves. So we tend to discount any effect on policy of these doctrines. However, many open-minded citizens halfway suspect that the learned scholars who publicly proclaim these views might know something that they do not. Maybe I really am just a robot controlled by my selfish genes; maybe purpose really is just an epiphenomenal illusion; maybe better and worse really are just meaningless terms for lending undue authority to subjective personal preferences, or to class-based, gender-based, or race-based interests. The fact that determinist or nihilist views cannot consistently be lived out in practice by individuals does not mean that their

[20] W. Berry, *Life Is a Miracle: An Essay Against Modern Superstition*, Washington, DC: Counterpoint Press, 2000.

existence, lurking in the back of the collective mind, is not capable of disabling policy.

In the Introduction, we referred briefly to the difficulty some ecologists have in dealing with policy, the messy world of human affairs. To the extent that the ecologist, like some biologists, is a determinist, then policy of any kind would be silly. Such an ecologist would necessarily be more laissez-faire than the most extreme free market economist. Hence our view that ecological economics is not simply a matter of bringing the light of ecology to dispel the darkness of economics. There is that to be sure, but there is also some darkness within ecology that economists do not need to import.

Perhaps we should take some cues from modern physics, just as traditional economics takes cues from nineteenth-century mechanical physics. Quantum indeterminacy and chaos theory have upset the "scientific" foundations of determinacy. And many of our greatest modern physicists, those who have best come to understand the physical matter underlying the scientific materialism paradigm, increasingly question its ability to provide any ultimate truths. For example, Einstein points out that scientific knowledge "of what is does not open the door directly to what should be." He goes on to ask "what should be the goal of our human aspirations? The ultimate goal itself and the longing to reach it must come from another source."[21] In Schrodinger's words, "the scientific picture of the real world around me is very deficient. It gives a lot of factual information, puts all our experience in a magnificently consistent order, but it is ghastly silent about all and sundry that is really near to our heart, that really matters to us—we do not belong to the material world the science constructs for us."[22]

Policy students, including economists, implicitly assume that the world offers more than one possibility to choose from, and that some choices really are better than others. This is also true, of course, for ecological economists who, while continuing to take biology and ecology very seriously, must not fall into the metaphysical traps of determinism or nihilism that seem to have ensnared some in those disciplines.

To be sure, not every conceivable alternative is a real alternative. Many things really are impossible. But the number of viable possibilities permitted by physical law and past history is seldom reduced to only one. Through our choices, value and purpose lure the physical world in one direction rather than the other. Purpose is independently causative in the world.

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[21]A. Einstein, *Ideas and Opinions*. New York: Crown, 1954. Quoted in T. Maxwell "Integral Spirituality, Deep Science, and Ecological Awareness." *Zygon: Journal of Religion and Science* 38(2): 257–276 (2003).

[22]E. Schrodinger, *My View of the World*, Cambridge: Cambridge University Press, 1964. Quoted in Maxwell, op. cit.

Box 3-1 Determinism in the History of Philosophy

Materialism, determinism, and mechanism are closely related metaphysical doctrines about the basic nature of reality. If you study the history of philosophy, you will see that they go back to Epicurus, Democritus, and Lucretius, over 2000 years ago, and these doctrines are still very much with us today. It would be arrogant for two economists to think that they can resolve this ancient puzzle, but also naïve to think that we can sidestep it, since economics is unavoidably about choice. If choice is an illusion, what does that say about economics?

Because humans are part of reality, it follows that, if matter in motion is all there is to reality, then that is all there is to humans as well. Since the motions of matter are determined by mechanical law, it follows that the same laws ultimately determine human action. This **determinism** rules out free will—it means that our purposes are not independently causative in the world. Only mechanical motion of matter is causative. Purposes, intentions, values, choices are all more or less dreams or subjective hallucinations. They are effects, not causes.

Nihilism, the rejection of all moral values, is the ethical consequence of the materialist, determinist cosmology. Things are what they are, and you can do nothing about it because your will and purpose have no power to change things. You can have no responsibility for what cannot be otherwise. For Epicurus this was a great relief—much better than worrying about the gods' anger and retribution, about responsibility and guilt and punishment. Relax, don't worry, do your best to enjoy life. Nothing can really hurt you, because when you are dead, that's the end and you can no longer suffer. This view is still very much alive in the modern secular world, although it has a long history of conflict with Christianity, Judaism, and Islam, as well as other philosophies that reject materialism as an adequate view of reality. They insist that good and evil are as real in our experience as matter, and that humans have at least some capacity for choice between them. To ignore our direct experience of good, evil, and freedom is considered antiempirical and against the deeper spirit of science.

It is not our intent to convert you either to or from Epicurianism, Christianity, or any other position. Maybe you do not yet have any position on this question. But logic does have its demands, and no doctrine is exempt from them. Even the early materialists recognized the contradictions involved in a doctrine that ruled out freedom, novelty, and choice. Epicurus tried to restore a modicum of freedom in an *ad hoc* manner by introducing the notion of the "clinamen"—the idea that atoms swerved from their determined motions for unexplained reasons, and that this was the source of novelty, and perhaps some degree of freedom. Our advice is to be skeptical of any easy answer to a problem that has been around for 2500 years, and also to be humble in the face of any logical contradictions that you cannot resolve.

The Ends-Means Spectrum

Ultimate means and the ultimate end are two extremes of an **ends-means spectrum** in the middle of which economic value is determined. In everyday life, it is our mid-range ends and means that interact, not their ultimate origins in the realms of the spirit or the electron. We will discuss this intermediate, mid-spectrum interaction in our consideration of the function of markets and relative prices (see Chapter 8). But for now it is useful to think of the entire ends-means spectrum depicted in Figure 3.1. The economic choices that exist in the mid-range of the spectrum are not illusory. They are not totally determined by material causes from below, nor are they rendered meaningless by an absence of final cause from above, or the presence of a predestining final cause. As we will discuss later, prices, relative values, are determined by supply and demand. But supply reflects alternative conditions of relative possibility, of the reality of ultimate means, while demand reflects independent conditions of relative desirability, rooted in notions of better and worse, of ethical choices based on some perception of the ultimate end.

In its largest sense, humanity's ultimate economic problem is to use ultimate means efficiently and wisely in the service of the ultimate end.

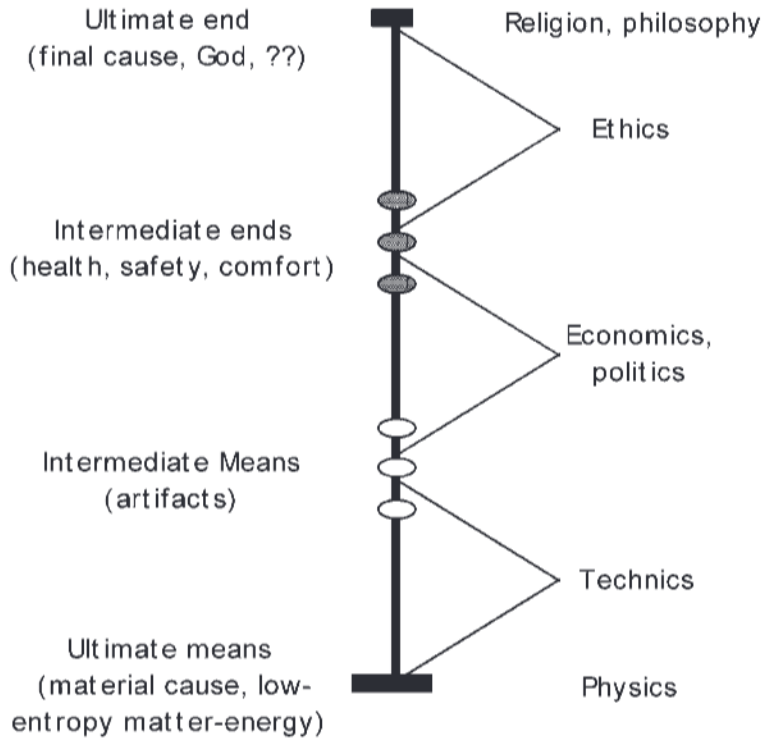

Figure 3.1 • The ends-means spectrum.

Stated in this way, the problem is overwhelming in its inclusiveness. Therefore, it's not hard to understand why in practice it has been broken up into a series of sub-problems, each dealt with by a different discipline, as indicated on the right side of the ends-means spectrum.

At the top of the spectrum, we have the ultimate end, studied by religion and philosophy. It is that which is intrinsically good and does not derive its goodness from any instrumental relation to some other or higher good. It is the highest good, to which all other good is instrumental and derivative. Needless to say, it is not well defined. As noted earlier, there are unacceptable consequences from denying its existence, but the dimness of our vision of the ultimate end is part of the human condition and requires a great deal of mutual tolerance. The error of treating as ultimate that which is not is, in theological terms, idolatry.

At the bottom of the spectrum is ultimate means, the useful stuff of the world—low-entropy matter-energy, which we can only use up and cannot create or replenish, and whose net production cannot possibly be the end result of any human activity. The ultimate end is much harder to define than ultimate means. Our current approximation to the ultimate end, unfortunately, seems to be economic growth, and part of the critique of economic growth is that our devotion to it has become idolatrous, worshipping a false god, so to speak, because it is not really ultimate. But it is not easy to formulate a central organizing principle of society that does not border on idolatry.

To reiterate, since we are forced by scarcity to choose which of our many intermediate ends will be satisfied and which will be sacrificed, we must rank our intermediate ends. Ranking means establishing priority. Priority means that something goes in first place. That holder of first place is our operational estimate of the ultimate end. It provides the ordering criterion for ranking other intermediate ends. Second place goes to whatever is nearest to or best serves first place, and so on. This ranking of intermediate ends relative to our vision of the ultimate end is the problem of ethics. Economists traditionally take the solution to the ethical problem as given and start their analysis with a given ranking of intermediate ends, or with the assumption that one person's ranking is as good as another's, so that ethics is indistinguishable from personal subjective tastes.

At the bottom of the spectrum, physics studies ultimate means, and technics studies the problem of turning ultimate means into artifacts specifically designed to satisfy each of our intermediate ends. Economists also habitually assume the technical problem to have been solved; that is, technology is taken as given. Thus, the remaining segment of the spectrum is the middle one of allocating *given* intermediate means to the service of a *given* hierarchy of intermediate ends. This is the significant and

important economic problem, or rather political economic problem, quite distinct from the ethical and technical problems.

The middle-range nature of the problem of political economy is significant. It means that, from the perspective of the entire spectrum, economics is, in a sense, both too materialistic and not materialistic enough. In abstracting from the ethical and religious problem it is "too materialistic," and in abstracting from the technical and biophysical problem it is not materialistic enough. Economic value has both physical and moral roots. Neither can be ignored. Yet many thinkers are attracted to a monistic philosophy that focuses only on the biophysical or only on the psychic root of value. Ecological economics adopts a kind of practical dualism. Dualism is not as simple as monism, and it entails the mysterious problem of how the material and the spiritual interact. That is indeed a large and enduring mystery. But on the positive side, dualism is more radically empirical than either monism, refusing to deny or ride roughshod over inconvenient facts, just to avoid confronting a mystery.[23]

Three Strategies for Integrating Ecology and Economics

Previous attempts to integrate economics and ecology have been based on one of three strategies: (1) economic imperialism; (2) ecological reductionism; (3) steady-state subsystem. Each strategy may be thought of as beginning with the picture of the economy as a subsystem of the ecosystem. The differences concern the way they each treat the boundary between the economy and the rest of the ecosystem (Figure 3.2).

Economic Imperialism

Economic imperialism seeks to expand the boundary of the economic subsystem until it encompasses the entire ecosystem. The goal is one system, the macroeconomy as the whole. This is to be accomplished by complete internalization of all external costs and benefits into prices. Price, of course, is the ratio (e.g., dollars per gallon) at which something is exchanged for money (or for some other commodity) by individuals in the market. Those aspects of the environment not customarily traded in markets can be treated as if they were by imputation of "shadow prices"—the economist's best estimate of what the price of the function or thing would be if it were traded in a competitive market. Everything in the ecosystem is theoretically rendered comparable in terms of its ability to help or hin-

[23]Honesty requires facing up to mystery. Although we suspect that mystery is an enduring part of the human condition and not just another word for "future knowledge not yet discovered," we nevertheless respect the scientific and philosophical quest to solve mysteries, including the mystery inherent in the dualism we advocate as a practical working philosophy.

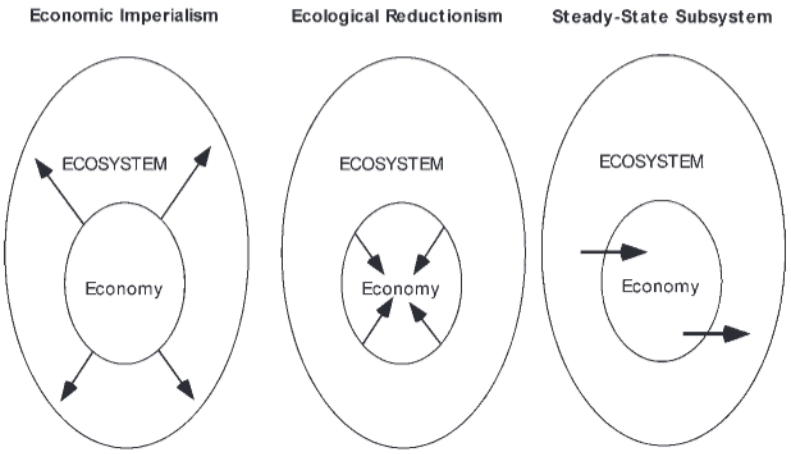

Figure 3.2 • Three strategies for integrating ecology and economics.

der individuals in satisfying their wants. Implicitly, the single end pursued is ever-greater levels of consumption, and the only intermediate means to effectively achieve this end is growth in market goods. Economic imperialism is basically the neoclassical approach.

Subjective individual preferences, however whimsical, uninstructed, or ill-considered, are taken as the source of all value. Since subjective wants are thought to be infinite in the aggregate, as well as sovereign, there is a tendency for the scale of activities devoted to satisfying them to expand. The expansion is considered legitimate as long as "all costs are internalized." But most of the costs of growth we have experienced have come as surprises. We could not have internalized them if we could not first imagine and foresee them. Furthermore, even after some external costs have become visible to all (e.g., greenhouse warming), internalization has been very slow and partial. As long as the evolutionary fitness of the environment to support life is unperceived by economists, it is likely to be destroyed in the imperialistic quest to make every molecule in creation, including every strand of DNA, pay its way according to the pecuniary rules of present value maximization.

Furthermore, this imperialism sacrifices the main virtue of free market economists, namely their antipathy to the arrogance of central planners. Putting a price tag on everything in the ecosystem requires information and calculating abilities far beyond anything attempted by Gosplan in the old Soviet Union.[24] As an example, let's take a look at what calculations

[24]Gosplan is the Russian acronym for the State Planning Committee, which centrally developed 5-year and annual plans for the Soviet economy, at all levels from individual enterprises to the national level.

would be required to accurately quantify and internalize the costs associated with global warming. Currently we are incapable of accounting for even carbon dioxide flows, the most basic piece of the puzzle. How much carbon is being absorbed by oceans or terrestrial ecosystems? How will it affect these ecosystems? Will global warming lead to positive-feedback loops, such as a release of methane from a thawing arctic tundra and increased atmospheric water vapor from more rapid evaporation from the oceans (both potent greenhouse gases), or negative-feedback loops via increased sequestration of carbon by forests? How will temperature changes affect global weather patterns over the next century? (And how certain can we be about such estimates, when we cannot even accurately predict the weather next week?) What changes would have occurred even in the absence of global warming? What technologies will evolve to cope with these problems, and how much will changing our rate of greenhouse gas emissions affect the rate of technological advance? Finally, how will these factors affect the economy? Bear in mind that while a meteorologist cannot accurately predict the weather in a week, she can at least stick her head out the window and say "it's raining." Economists, on the other hand, at the time of this writing are in the midst of a heated debate over whether or not the economy is in a recession *right now*.

These calculations, a small fraction of those that would be required to estimate the costs of global warming, are clearly beyond the capabilities of modern science, and quite probably beyond the capacity of the human mind. And calculating all the costs at the time they occur is the straightforward part. How do we determine the present value of costs to future generations? The currently favored approach, intertemporal discounting (to which we return in Chapter 10) gives less value to future costs and benefits than those that occur today, and the discount rate we choose in this calculation is likely to be as important as any other of the variables mentioned above. But discounting in this case implies that future generations have no inalienable right to a stable climate, economic growth will continue throughout the discount period, and economic growth is a satisfactory substitute. Yet the discount rate we choose for internalizing costs will itself affect the rate of growth.

The global warming example brings up another serious problem with economic imperialism—the assumption that the most efficient mechanism for allocating virtually any means among any ends is the market. In fact, markets are incapable of allocating goods that cannot be owned, and inefficient at allocating goods for which use does not lead to depletion (either or both of which are properties of the bulk of ecosystem services). Even if we could put an appropriate charge on greenhouse gas emissions to internalize their costs, who would receive the charge? It would seem only fair that it would go to those who bear the costs. Would it even be a

market transaction if when we purchased something, we did not pay the person who bore the costs of production? However, global warming is likely to affect virtually the entire population of the planet for countless generations into the future. This would imply that not only would we need to calculate all the costs, we would need to do so for *each individual*. Strangely enough, as we will discuss later, some neoclassical economists argue that those who bear the costs of externalities should not receive the payments,[25] but in this case, how could we say that the result resembles a market solution? A major goal of this text will be to explain exactly why many goods and services are not amenable to market solutions, independently of whether or not we are able to internalize all costs.

Let's play the role of the stereotypical economist and assume away all these problems. There is, then, no doubt that once the scale of the economy has grown to the point that formerly free goods become scarce, it is better that these goods should have a positive price reflecting their scarcity than to continue to be priced at zero. But there remains the prior question: Are we better off at the new scale with formerly free goods correctly priced, or at the old scale with free goods also correctly priced at zero? In both cases, the prices are right. This is the suppressed question of optimal scale, and it is not answered by market prices.

Ecological Reductionism

Ecological reductionism begins with the true insight that humans are not exempt from the laws of nature. It then proceeds to the false inference that human action is totally explainable by, reducible to, the laws of nature. It seeks to explain whatever happens within the economic subsystem by exactly the same naturalistic principles that it applies to the rest of the ecosystem. It shrinks the economic subsystem to nothing, erasing its boundary. Taken to the extreme, in this view energy flows, embodied energy costs, and relative prices in markets are all explained by a mechanistic system that has no room for purpose or will. This may be a sensible vision from which to study some natural systems. But if one adopts it for studying the human economy, one is stuck from the beginning with the important policy implication that policy makes no difference. We encounter again all the problems of determinism and nihilism already discussed.

Economic imperialism and ecological reductionism have in common that they are monistic visions, albeit rather opposite monisms. It is the monistic quest for a single substance or principle by which to explain all value that leads to excessive reductionism on both sides. Certainly one

[25]E. T. Verhoef, "Externalities." In J. C. J. M. van den Bergh, ed. *Handbook of Environmental and Resource Economics*, Northhampton, MA: Edward Elgar, 1999.

should strive for the most reduced or parsimonious explanation possible without ignoring the facts. But respect for the basic empirical facts of chance and necessity on the one hand, and self-conscious purpose and will on the other hand, should lead us to a kind of practical dualism or polarity reflected in the ends-means spectrum. After all, the fact that our being should consist of two fundamental elements offers no greater inherent improbability than that it should rest on one only. How these two fundamental elements of our being interact is a mystery—precisely the mystery that the monists of both kinds are seeking to avoid. But economists are too much in the middle of the spectrum to adopt either monistic "solution." Economists are better off denying the tidy-mindedness of either monism than denying the untidy and mysterious facts.

The Steady-State Subsystem

The remaining strategy, is the **steady-state subsystem**, the one adopted here. It does not attempt to eliminate the subsystem boundary, either by expanding it to coincide with the whole system or by reducing it to nothing. Rather, it affirms the fundamental necessity of the boundary and the importance of drawing it in the right place. It says that the scale of the human subsystem defined by the boundary has an optimum, and that the throughput by which the ecosystem maintains and replenishes the economic subsystem must be ecologically sustainable. Once we have drawn this boundary in the appropriate place, we must further subdivide the economic subsystem into regions where the market is the most effective means of allocating resources, and regions where it is inappropriate. These regions are determined by inherent characteristics of different goods and services, to be discussed at length in this text.

Box 3-2 The Steady-State Economy

The idea of a steady-state economy comes from classical economics, and was most developed by John Stuart Mill (1857), who referred to it as the "stationary state." The main idea was that population and the capital stock were not growing. The constancy of these two physical stocks defined the scale of the economic subsystem. Birth rates would be equal to death rates and production rates equal to depreciation rates, so that both the stock of people (population) and the stock of artifacts (physical capital) would be constant—not static, but in a state of dynamic equilibrium. Most classical economists dreaded the stationary state as the end of progress, but not Mill:[a]

It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for improving the Art of Living and much more likelihood of its being improved, when minds cease to be engrossed by the art of getting on.

Mill thought we would pay more attention to getting better, once we ceased to be so preoccupied with getting bigger. He also recognized that growth could become uneconomic:

If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not a happier or better population, I sincerely hope, for the sake of posterity, that they will be content to be stationary, long before necessity compels them to it.

In physical terms, populations of both human bodies and things are what physicists call "dissipative structures"—things that fall apart, die, and decay if left to themselves. People die, goods wear out. To keep a population of dissipative structures constant requires births equal to deaths, and production equal to depreciation—in other words, input equal to output equal to throughput, a concept with which you are now familiar. But births can equal deaths at low rates or at high rates. Either one will keep the population constant. Which do we want? If we want a long life expectancy for individuals, we must chose low birth rate equal to low death rate. For an equilibrium population with birth equal to death rates at 40 per thousand per year, the average age at death must be 25 years. If we want people to live to be 67 rather than 25, we will have to lower birth and death rates to 15 per thousand per year. Can you explain why? Can you apply the same logic to lifetime or durability of the stock of goods?

To summarize: The main idea of a steady-state economy is to maintain constant stocks of wealth and people at levels that are sufficient for a long and good life. The throughput by which these stocks are maintained should be low rather than high, and always within the regenerative and absorptive capacities of the ecosystem. The system is therefore sustainable—it can continue for a long time. The path of progress in the steady state is no longer to get bigger, but to get better. This concept was a part of classical economics, but unfortunately was more or less abandoned by NCE. More precisely, the terms *stationary* and *steady state* were redefined to refer not to constant population and capital stock, but to their proportional growth—a constant ratio between ever-growing stocks of people and things!

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[a] *J. S. Mill,* Principles of Political Economy, Book IV, *Chapter VI (1848). Online: http://www.econlib.org/library/Mill/mlPbl.html.*

BIG IDEAS to remember

- Practical dualism versus monisms
- Presuppositions of policy
- Ultimate means
- Ultimate end
- Information and knowledge
- Determinism and materialism
- Ends-means spectrum
- Economic imperialism
- Ecological reductionism
- Steady-state subsystem