

Toward an Economics of Sustainability

John E. Ikerd

University of Missouri

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PREFACE

The question of sustainability has become an important economic, political, and social issue. Major international conferences have been held to discuss the issue of global sustainability. A President's Council on Sustainable Development was formed to address sustainability questions confronting the United States. After nearly a decade of indecision, the U.S. Department of Agriculture has officially embraced sustainable agriculture as a priority issue for the future. Questions of sustainability has also become commonplace both in professional publications and in the popular media.

Economists have remained one of the most reluctant groups within the scientific community to address the issue of sustainability. Economists tend to treat sustainability as a resource economics issue, a public policy issue, or an economic development issue. The economics of sustainability is treated pretty much as the "economics of externalities", even by most contributors to the new international Journal of Ecological Economics. Even more significant, the issue is largely ignored by most people in the economics profession.

Why are economists reluctant to recognize sustainability as a major public and professional issue? Perhaps because the concept of sustainability is fundamentally incompatible with conventional economic theory. The study of "sustainability" will require a new, more inclusive theory of economics. Daly and Cobb, Capra, Berry, and others have pointed out some of the limits of current economic theory in addressing sustainability issues. Most such critics of economics, however, have suggested changes in public policy as a means of addressing this new class of "market failures". Some have questioned the foundations of economics as a science (McCloskey), but despite claims to the contrary (Daly, Common and Perring); no one has suggested writing a new theory of economics. New theory, rather than new public policy based on old theory, will be needed to guide humanity toward sustainable development. The purpose of this paper is to outline a case for developing such a theory -- an "economics of sustainability."

The concept of sustainability is far broader than conventional economic theory. Daly and Cobb refer to conventional economics as "chrematistics" -- the "manipulation of property and wealth so as to maximize short-term monetary exchange value to the owner". Sustainability is also broader than current ecological or social theory -- it includes "chrematistics". But sustainability is quite consistent with the root-word for economics, "oikonomia" -- "management of the household (community, society, humanity & biosphere) so as to increase its value to all members over the long run" (p. 138). Daly and Cobb propose an "economics of community", which they would achieve through changes in government policies. The proposal put forth in this paper, instead, is to develop a new theory -- sufficiently broad to encompass "oikonomia", for the purpose of guiding sustainable, long run human progress. New policies could then be built upon this new theoretical foundation.

No attempt is made in this paper to develop the new theory. If such a theory is to be developed it will take scholars (perhaps many scholars), writing books (perhaps many books), over years (perhaps many years). But, a “journey of a thousand miles begins with a single step” -- so states the old proverb. The objective of this paper is to lay the foundation for that “first step”.

This is not a scholarly paper, at least in the conventional sense. It does not include an extensive review of literature nor is it heavily referenced. This paper is a product of a long intellectual journey. There was no initial intent to take this trip or to arrive at this destination. Thus, no journal was kept to document either the route taken or the many people who have unknowingly provided guidance along the way. Ultimately, the journey may need to be retraced. But for now, I will simply not claim anything here to be original with me. I quite likely discovered it all in the work of someone else. All I have done is rearranged it. I will cite specific sources in the text -- in cases where I can recall them and find them. I will also provide a reference list at the end with as many sources as I can remember that have added significantly to my thinking. For now, I only hope to provide a compass for more scholarly works that might follow.

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John E. Ikerd
University of Missouri
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The Issue of Sustainability

Sustainability is a long run, people-centered concept. There have been many attempts to define sustainability, but most are rooted in the general concept of intergenerational equity. Sustainable development, as used in this paper, means meeting the needs and wants of people of the current generation while leaving equal or better opportunities for people of generations to follow. What is to be sustained? -- development of resources: natural, human, and economic. What is the purpose of development? -- positive change or human progress, not necessarily growth in numbers or size. Who is to benefit from such development? -- people of the current generation and of generations to follow. For how many generations is development to be sustained? -- for all future generations, forever. Thus, sustainability is about sustaining a desirable quality of life for people, forever.

Some find fault with the anthropocentricity -- human-centeredness -- of this definition. However, if we are not concerned, uniquely, with sustaining progress of the human species, there is no management issue to be addressed. We can simply depopulate or otherwise reduce human claims on resources to a point where the sustainability of other species is no longer in question, or at least is not threatened by humans. However, human nature is not unlike the nature of other species, in that we humans have an innate instinct for survival, reproduction, and self-gratification.

We will not reduce our claims on resources for the sole purpose of ensuring the sustainability of other species. But, we will do so if we perceive it to be in “our” best interest. The fact that we are concerned “uniquely” with sustaining the human species does not imply that we are concerned “exclusively” with sustaining the human species. Unlike the economics of “chrematistics” might

imply, “our” best interest is not exclusively individualistic in nature. Our interests as members of society and as members of the human species are linked with self-interest through “oikonomia”. Thus, “our” interests may well be served best through sharing and stewardship, including preservation of other species, rather than through expressing individual human greed -- through “oikonomia” rather than “chrematistics”. However, we have no conceptual road map, or theory, to guide us from “chrematistics” to “oikonomia” in the pursuit of “our” best interest.

The issue of sustainability is rooted in a set of questions: is our economy sustainable, is our society sustainable, is human life on earth sustainable, is the earth sustainable?... if we continue to pursue the goals of conventional economic development. Many have answered these questions -- no! They believe that we are on a road that can lead only to total depletion of the natural resource base and ultimate destruction of the human species. Others answer the question -- yes! They believe the pursuit of short run profits through responding to consumer preferences is the only logical means of optimizing resource allocation, and thus, sustaining human progress.

Sustainability, as a consequence of its long-run nature, will remain a question with no definite answer, a direction without a precise destination, a process without a final product. We can never know with certainty whether any particular approach, method, or activity is sustainable or not sustainable. Just because something has been sustained until now, does not mean it can be sustained forever. Just because something has not been sustained up to now, does not mean that it could not have been sustained, until now and into the future. We cannot prove empirically that anything is or is not sustainable in the long run. The long run is forever.

What we can do is make logical, informed judgments concerning the “likelihood” that something will or will not be sustainable. However, even here, there is no general agreement concerning the logical foundation for making such judgments. The believers in the economics of “chrematistics” see no limits to growth. They believe, implicitly, that human ingenuity is infinitely substitutable for limited natural resources. Thus, production and consumption of economic goods and services can continue to grow indefinitely. If such is the case, there is no legitimate question of sustainability. Human development is sustainable, by assumption.

However, the emergence of sustainability as a major public issue reflects a fundamental challenge to the assumption of unlimited growth. Concerns for sustainability are not rooted in scientific observation, even though the growing abilities of humanity to degrade the natural resource base and to wipe out large segments of human society clearly are observable. Those who are concerned about sustainability “believe” we must find better ways of utilizing our natural and social resource bases in order to sustain human progress on earth. They believe these resources are finite, and thus, ultimately will limit growth in human consumption. They reject the belief that science and technology will yield substitutes for depleted resources, including extinct biotic life forms. They reject the belief that fundamental laws of nature ultimately can be repealed through human ingenuity.

We must recognize that conflicting “beliefs”, not conflicting “facts”, are at the root of the sustainability issue. Conventional economic theory is rooted in the “belief” that there are no limits to growth. The sustainability issue is rooted in the “belief” that there are limits to growth. Neither “belief” can be proven to be true or false.

McCloskey calls the Modernistic view that underlies current economic thinking a “revealed, not a reasoned, religion” (p. 6). It is believed that maximization of profits and consumer satisfaction in an open-market economy is consistent with maximization of human well being, and that market failures can be corrected through public policies. The economics of sustainability is based on a different belief system -- a belief that short-run maximization of profits and individual consumer satisfaction ultimately will deplete both the natural and social resources upon which human well being and survival of the species depend.

According to Einstein, problems cannot be solved at the same level of thinking that lead to their creation. If so, problems arising from “old” economic thinking cannot be solved using “old” economic thinking. A “new” economics of sustainability cannot be derived from the economics of the “old” belief system that is at the root of most sustainability issues. It must build from the ground up, starting with a new belief system.

Inadequacies of the “old” economics

The inadequacies of the “old” economic theory in addressing issues of sustainability have been fairly well documented by others writing in reference to ecological economics, sustainable agriculture, and related issues. However, a rehashing of some of the deficits of the old theory, with some extrapolation and syntheses, may provide a useful preface to developing a conceptual framework for its proposed replacement.

The “old” economics is an extractive science. The discipline of economics addresses the allocation of scarce resources among competing ends. It deals with the transformation of basic resources into consumer goods and services. All the old economics is capable of doing, even under the ideal assumptions of perfect competition, is to ensure that resources are “used up” in ways (i.e. allocated to uses) that accurately reflect the tastes and preferences of individuals as consumers. There is nothing in economics that ensures the regeneration or sustainability of the stocks of resources, either natural or human, which are required to support production of consumer goods and services for current and future generations.

The “old” economics is a unidimensional, consumptive science. There is nothing within economic theory that reflects human values in terms other than people as consumers or as producers of goods for consumption. Society, the environment, and even preferences for non-consumption goods are considered as external to the economic decision making process. Economic decisions concern the allocation of resources among consumptive uses. Consumer tastes and preferences, societal restrictions or regulations, and environmental constraints are all taken as given. Generation of human satisfaction through social interactions and through resource stewardship is beyond the scope of the “old” economics.

The “old” economics is a science for managing scarcity. Resources have no “economic” value unless or until they become scarce. Economics provides no guidance in the use of vital resources, such as air and water, until they are degraded in quantity and quality to a point where they become scarce. For example, direct payments for water are mostly payments for the convenience of having water when and where we want it. Historically, economics allocated the use of

convenience but not use of the water. Drinking water was free to be wasted -- it had no economic value -- until it was polluted and thus became scarce.

The “old” economics is a reductionist science. It assumes a world of separability. Economic theory does not exist in the absence of the term “ceteris paribus” -- other things held constant. The most fundamental “law” of economics, diminishing marginal returns, is meaningless without the assumption of “ceteris paribus.” Economics is fundamentally incapable of addressing issues of interconnectedness in a “holistic” world. In a world made up of “wholes” rather than “pieces”, we cannot do one thing without affecting something else. There is no “ceteris paribus”. We must learn to manage the whole rather than tinker with its parts. Perhaps the most naive “ceteris paribus” assumption in the whole of economics is: that one may manage those things called “economic” without simultaneously and unavoidably impacting those things called “social” and “spiritual” as well.

Finally, the “old” economics paradigm is based on times past, which are reflective neither of the present nor of the likely future. Adam Smith's economic paradigm of the “invisible hand” probably was a fairly accurate representation of how the world worked 200 years ago, and perhaps was not too bad a model until a few decades ago (see Brewster). Most economic enterprises were small, family operations. Land, labor, capital, and management all resided in essentially the same entity. Few enterprises were large enough to have any impact on the marketplace as a whole. Price signals were clear because connections between producer and consumer were simple and often personal. Human populations were small enough and technologies were such that it seemed as if people could have little permanent impact on their natural environment. Strong cultural, moral, and social values dictated norms and standards of “acceptable” individual behavior. Under these conditions, the “invisible hand” may well have guided the pursuit of individual self-interest to the benefit of society, at least for the current generation.

But the paradigm of 200 years ago holds little resemblance to the world of today. Today, most sectors of the U.S. economy, for example, are dominated by large corporate enterprises. Corporations are not only non-family but are non-human entities, regardless of the nature of their stockholders. The resources of land, labor, capital, and management are now separate, not just among households and organizations but, in many cases, among nations. No longer can one assume that people in their roles as laborers or managers will be accurately rewarded in relation to their contribution to the productivity of land and capital. Corporate profits are far larger than any concept of “normal” profit envisioned in classical economics. For example, a 1995 congressional study of the U.S. breakfast cereal industry reported corporate profits ranging from 24 to 43 percent annual returns on equity for the four largest corporations. While such profits may or may not be “sinful”, they most certainly distort the allocation of resource use so as to cripple, if not amputate, Smith's “invisible hand”.

Producers and consumers have become disconnected, geographically and conceptually, as a consequence of specialization, mechanization, and development of complex systems of mass production and distribution. Consumers no longer have any personal knowledge of where their products come from or of who is involved in their production. They must rely on a complex set of standards, rules, and regulations to ensure that performance of a good or service will be

consistent with some minimum expectations formed at the time of purchase. Today's advertising consists of "disinformation" by design. Most people involved in current production processes, including dispassionate stockholders, have little individual control over the ability of final products to meet consumers' expectations nor are they committed to the long term success of the economic enterprises in which they invest. They expect to shift their investments and employment with shifts in a company's ability to generate profits and growth.

Actions of people in pursuit of self-interests are no longer ecologically benign -- if they ever were. The pressures of growing populations and rising per capita consumption are now depleting resources of the land far faster than they can be regenerated by nature. Wastes and contaminants from human activities are being generated at rates far in excess of the sink capacity of the natural environment to absorb and detoxify them. The thin layer of topsoil that supports production of food and fiber has been eroded away far faster than it has been, or ever could have been, regenerated by nature. Attempts are rarely made to recreate old forest ecosystems, but instead to maximize short run economic value of fiber production in places where old growth forests once stood.

Fossil fuels, the engine of twentieth-century economic development, are being depleted at rates infinitely faster than they can ever be replenished. Environmental pollution, a direct consequence of "economic development", is degrading the long run productivity of land, water, and air resources. Human population pressures are destroying other biological species, upon which the survival of humanity may be ultimately dependent. The current rate of species extinction is unprecedented -- except possibly during geologic events now characterized as global disasters. The human species is now capable of destroying almost everything that makes up the biosphere we call Earth, including humanity itself.

Cultural, moral, and social values now seem to present few constraints to decisions of self-interest. Free market societies appear to have become convinced the "invisible hand" is quite capable of turning the "greatest individual greed into the greatest societal good." Government intervention is expected to correct any market failures through laws and regulation. So any action that is legal and profitable is considered to be "good" for society. Cases of differences in opinion with respect to legality are settled in the courts. People appear to feel no moral responsibility to pursue the common good beyond obeying laws and responding to markets. Confidence in the "old" economics seems to be peaking, just as it is losing any relevance to reality. One reason the "old" economics "worked" was that it was not trusted. Decisions were constrained by social norms and ethical values. Eroding social norms and values have been correlated with a growing belief in the "goodness of greed" -- perhaps reflecting more than mere coincidence.

Economics of Sustainability

So where do we begin to develop the "new" economics?

Axioms. All theory is based on axioms. Webster defines an axiom as "a maxim widely accepted on its intrinsic merit, or a statement accepted as true as the basis for argument or inference". The following are proposed axioms for a new theory of economic sustainability.

- To sustain a desirable quality of life is the basic purpose of all human endeavors.
- A dynamic balance among inseparable ecological, social, and economics dimensions of quality of life is necessary for its sustainability.
- Energy, the essence of all biological life, is finite in quantity and availability.
- The capacity of the natural environment to absorb and detoxify waste is limited.
- Solar energy and human life are linked through non-human, biological processes.
- Nature and humanity are linked through spiritual, as well as, physical bonds.
- Humans are a social species, and thus, are inherently interdependent.
- The purpose of an economy is to facilitate mutually beneficial relationships among people and between people and their natural environment.
- People of any future generation have a basic right to opportunities for a quality of life equal to or better than those of any current generation.

Paradigms. Theory, according to Webster, refers to “a body of theorems presenting a concise, systematic view of a subject”. So defined, a theory should include a body of theorems which constitute a paradigm, a mental model or mind set, that can be used to guide actions or decisions. According to Joel Barker, a paradigm should do three things: (1) establish boundaries, (2) establish goals, and (3) establish rules.

The “old” theory of economics describes a paradigm for economic decision making. First, the old boundaries separate the decision-maker from society and the natural environment. The decision-maker is impacted by and has impacts upon society and the environment, but these things are clearly “outside” of the boundaries of decision making. Otherwise why would economists refer to social and environmental impacts as “externalities?”

Second, the goal of the “old” economic paradigm is to maximize consumer utility or usefulness from scarce resources. The production objectives assumed to lead to this goal are maximum profit and growth. Profits and growth are considered to be a reflection of success. Losses and decline are considered to be failures.

Third, the rules of the “old” economic game are defined by constraints to maximization. Anything that is possible and legal is OK -- and should be pursued if it maximizes profits and growth. It is assumed that consumer utility or satisfaction is maximized also through this process of constrained profit maximization.

The “new” economics of sustainability represents a different paradigm. It has different boundaries, different goals, and different rules.

First, society and the natural environment are “inside”, rather than “outside” the boundaries of the sustainability paradigm. Social and environmental strategies are just as important as economic strategies in ensuring long run sustainability. Thus, society and the environment must be considered a part of, rather than apart from, the whole that is to be managed.

Second, the goal of sustainability is to ensure opportunity for a desirable “quality of life” for those of the current generation and of all generations to follow. Quality of life has inseparable ecological, social, and economic dimension. Thus, the three are but different dimensions of a

single holistic goal (see Savory). Over the long run, systems cannot be ecologically sound unless they are also economically viable and socially responsible. They cannot be economically viable unless they are also ecologically sound and socially responsible. They cannot be socially responsible unless they are also economically viable and ecologically sound. All are necessary and none, alone or in pairs, is sufficient to ensure sustainability. All three are essential dimensions of the goal of sustainability.

Finally, the rules of the sustainability paradigm are the laws of nature, including human nature. A desirable quality of life cannot be sustained if the laws of nature are violated. Thus, the laws of nature, including human nature, define the constraints within which sustainability must be achieved. The fact that something is possible and legal does not imply it is right. The new paradigm includes inviolate, “true north” principles of physical, social, and spiritual relationships upon which a sustainable human society must be based.

An obvious question at this point might be: Why develop a new theory of “economics” rather than a generic theory of “sustainability?” The answer: a theory for “management” or “human decision making” for sustainability is an “economic” theory of sustainability. The fundamental purpose of an economy is to facilitate interactions among people and between people and their natural environment. Whenever people move beyond isolation and self-sufficiency, they become involved in the “economy.” Under the “old” economics, non-transactional interactions among people and between people and their natural environment were deemed non-economic. But, when economics is expanded to mean “oikonomia” (management of the household, community, society, humanity, and biosphere so as to increase its value to all members over the long run), it must include “all” interactions within society and between society and the environment.

Models. “Old” economic models are based on principles of Newtonian physics (see Capra). They are mechanical models expressed in mathematical symbols or graphics. The underlying assumption is that economic phenomena can be expressed by precise relationships, as in the relationships among different parts of a machine. Even stochastic models are based on assumption that “precise” relationships exists. Probabilities are assigned to the likelihood that we have or have not been able to define that precise relationship through our scientific observation.

“New” models of economic sustainability must be built upon a different set of principles. For example, economic, ecological, and social dimensions are inseparable dimensions of the same whole or the same organism. This axiom, among others, precludes the mechanical separation of sustainability into component parts. In addition, when sociological and ecological processes become central to economics, the proposition that economics can be reduced to a series of equations and graphs becomes indefensible. Societies and ecosystems are living organisms, not machines. Consideration of the spiritual goes even beyond the living. A strong case can be made for using Quantum rather than Newtonian models for living systems (Capra). The “newer” theories of Quantum physics seem much more appropriate for modeling the “new” economics.

Does it really matter whether or not we use biological rather than mechanical models in matters related to sustainability? Some common sense illustrations of fundamental differences between mechanical and biological systems seem to indicate that it does matter. First, if a critical part breaks on a machine, -- say a piston goes out in a gasoline engine -- the engine stops. But you

can replace the piston and start the machine again. It runs as good as before. If a critical “part” breaks in a living organism, -- say a heart stops beating -- the organism dies. You can put a live heart in a dead carcass, but it won't come back to life. It is dead, forever. If a living organism gets sick, however, and you correct the basic problem, the organism will heal itself. It will become well again on its own. If a critical part is wearing out on a machine, it doesn't fix itself, even if you fix the problem that is causing the wear. Eventually, you have to fix it. Finally, living organisms are self-regenerating. Given an opportunity, they reproduce by nature on their own. Machines are fundamentally incapable of reproducing themselves.

These analogies might seem trivial at first, but they all relate directly to the fundamental issues of sustainability. A mechanical world is not sustainable; a biological world just might be. Thus, logic would seem to dictate that the new economics of sustainability be developed using biological or organismic models rather than mechanical models.

The theories of quantum physics relate specifically to the nature of phenomena at the atomistic level. However, if quantum theories are valid, all phenomena at all levels of organization are interconnected, and thus, all things true at the atomistic level are true of all higher and lower levels of organization. Some important characteristics of Quantum-based models include the following:

- Objects do not have properties independent of their environment. Relationships or interconnectedness determines reality. Thus, everything is site and situation specific -- some interconnections are just weaker than others are.
- All phenomena are dynamic. It is impossible to isolate cause and effect, even in cases of obvious correlation. Variables are neither independent nor dependent, but are interdependent. Intervention, rather than initiation, is the engine of change.
- We cannot observe anything without changing what we observe. “Facts” are a function of human consciousness. Our assumptions about the nature of phenomena actually shape the phenomena we observe.
- Sustainable systems trend toward dynamic equilibrium, continuous oscillation between polar opposites, not toward some steady state. Dynamic balance is the essence of quantum equilibrium.
- Phenomena are “chaotic” and subject to sudden “quantum” changes. But there is order within the chaos.

For things “obviously mechanical”, interconnections are weak, dynamics are indiscernible, and order dominates chaos. For such phenomena, mechanical models work well. However, for things “obviously biological”, interconnections are strong, dynamics are undeniable, and chaos often seems dominant over order. Economic systems would seem to fall far closer to the biological or organismic end of the continuum. Mechanical economic models may have been marginally acceptable for short-run profit driven decisions. However, long run sustainability issues seem to demand an organismic approach to economics.

Based on the axioms and principles above, an organismic model of the economic sustainability paradigms is presented as a starting point for developing new economic theory (Figure 1). The

primary purpose is to illustrate what a biological model of economic sustainability might look like and how it might differ from the “old” mechanical model of economics.

First, focus on the elements of the systems model within the “old boundaries” of economics. The SEE-QOL circle represents “consumers” and the PFH-ECAP box represents “producers” in traditional economic terms. Note the typical flow of goods and services from producers to consumers and the flow of inputs (labor, management) and investments (land, capital) in the opposite direction. The “delay” or break between “investment” and the resulting flow of goods and services signifies a multi-period time lag (following Senge).

Society and the environment affect consumers both directly and indirectly through the economy. But only the indirect impact (through ECAP) is part of the “old” economics. The extractive impacts of the production on social capital (SOC-CAP) and ecological capital (ECOL-CAP) and the direct impacts of society and the environment on consumers are all “externalities” -- are outside the old economic boundaries.

The environment and society become of part of the “old” economy, only at the point where ecological capital is converted to physical capital (P), social capital is converted to human capital (H), and the two are combined with financial capital (F) to produce economic capital (ECAP). The purpose in accumulating economic capital (ECAP) is to enhance the extraction process, not to rebuild long run social or ecological capital stocks. The rebuilding and depletion of long-run ecological and social capital stocks is external to the “old” economic system.

The SEE-QOL circle represents “people” rather than “consumers” in the “new” economic model. SEE-QOL is used to signify that quality of life has economic, ecological, and social dimensions, whereas the terms consumer and producer relate only to the economic dimension of people. Note also ecological and economic investments go from “people”, rather than the producers, to rebuild ecological and social capital. Social and ecological investments are not a part of the “old” economics, but are critical aspects of the economics of sustainability.

Social and ecological capital stocks are included within the “new” economic boundaries because they must be managed to ensure sustainability. Thus, the extraction of economic capital from ecological and social capital also takes place within the new boundaries. Economic capital is extracted from ecological and social capital anytime physical and human resources are combined with financial capital and converted into an economic good or service.

Figure 1. Economics of Sustainability Paradigm



SEE-QOL: Social, Economic, Ecological: Quality of Life
PFH-ECAP: Physical, Financial, Human: Economic Capital
SOC-CAP: Social Capital
ECOL-CAP: Ecological Capital

There are no flows directly from the economy to either ecological or social capital. Direct economic investments in human capital and environmental protection are internal investments made only to enhance the extractive process. One might argue that producers in the old economic model actually do invest in ecological and social capital. For example, many corporations invest voluntarily in environmental protection and community betterment projects. However, such investments must have a quantifiable, expected payoff to be a rational economic investment under the old assumptions of rational economic decision making. In addition, the expected payoff must exceed the expected investment -- appropriately discounted for risk and time preferences. The sum of expected extractions must exceed total investments. Intentional net addition stocks of ecological and social capital are not "economically rational". Thus, any actual net additions to social or ecological stocks are coincidental rather than intentional.

Investments in economic and social capital in the new model are motivated by incentives other than individual self-interest. A positive net QOL payoff is expected, but the "direct" payoff from their investment may well accrue primarily to other people at various times in the future. The new economics assumes people realize that current social and ecological benefits result from "collective" investments made by "communities" of people both of current and of past generations. Thus, we feel a "need" to invest for the benefit of others of current and future generations. The direct benefits of such investments are reflected in our ecological, spiritual and social quality of life rather than in economic returns.

Ecological and social investments fit a "chaotic" model of decision making. General "patterns" of investment-reward cycles are clear and definite, but linkages between individual investments and individual returns are chaotic, unpredictable, and thus not subject to rational "economic" decision making. Spiritual and social investments are based on a collective faith and confidence that those who do the "right thing" will somehow be rewarded at some time-- not on calculated, discounted net cost-benefit ratios. The faith and confidence in the "rightness" of the decision generates its own reward.

One of the most important differences between the "old" and "new" economics is not readily apparent in the flow diagram. In the "new" economics, it is impossible to isolate cause and effect. Price is neither a function of quantity, nor quantity a function of price. Both are interdependent with feedback loops in both directions. This new assumption seems far more consistent with the logic of supply and demand. The practice of defining quantity as a function of price gained acceptance only because it made no less sense than defining price as a function of quantity. We felt we had to do one or the other. "New" economic models are dynamic. Cochrane's "technology treadmill" seems far more consistent with Senge's approach to dynamic systems modeling than with the comparative static models of economics. "New" economic models are interconnected through time and across space. Cycles in prices of commodities and in general economic activity seem far more consistent with an organismic, rather than mechanistic, model of economic activity.

The delays in flows between "people" and stocks of social and ecological capital (in both directions) imply unpredictable linkages -- ranging from short term to multi-generational. Many of the benefits currently derived from social and ecological capital come from investments made decades, centuries, or eons in the past. Current investments in ecological or social capital

likewise may occur at distant times in the future. But, if investments consistently fall short of withdrawal, social and ecological stocks will most certainly be depleted over time. People make such investments as sustainers of humanity, not as short-run maximizers of individual self-interest. The old economic processes of discounting future costs and benefits and calculating net present values are simply irrelevant in making such investments. Under the old economics, decisions made solely to sustain humanity are considered to be irrational.

Ecological and social capital stocks are replenished by natural self-regenerating processes as economic extraction and direct flows of benefits to people deplete them. The natural biological process of resource regeneration -- the continual conversion of energy to matter and matter to energy replenishes ecological capital. In addition, solar energy, the only "outside" source of energy continually adds to stocks of ecological capital. Social capital stocks are regenerated through culture, the natural human tendency to pass on knowledge and wisdom from one generation to the next. The natural regeneration processes, however, are outside the "new" boundaries as well as the "old". The laws of nature are "outside" of the realm of human control or management. These laws are the rules under which new economic system must be sustained.

Sustainability requires that the stocks of ecological and social capital be maintained. Thus, the total of direct and indirect extraction cannot be sustained at levels in excess of levels of regeneration. The balance of intentional extraction minus intentional regeneration - those flows within the "new" economic boundaries - cannot be sustained at levels that exceed the rate of natural regeneration. In the past, when people were geographically separated into more or less isolated societies and when total human impacts on the ecosystem were small, there was little cause to be concerned about global resource depletion. If one society fell into social depravity and destroyed its local resource base, it would decline and die out. Each society would be succeeded by another, which had built and maintained its ecological and social capital.

Economics did not make people self-destructive, but it gave them added incentives and better means of pursuing this aspect of their basic nature. Consequently, today there is now growing evidence of global ecological and social capital stocks being depleted at rates far in excess of natural regeneration rates. A dynamic systems model that recognizes interconnectedness might be used to confirm that the current market dominated economy is locked in a self-generating cycle of accelerated destruction. The "old" economy neither recognizes nor rewards the ecological and social contributions to quality of life. Thus, there is no logical economic reason to intentionally maintain or rebuild stocks of social and ecological capital -- only to convert them to economic capital.

Without reinvestment, the flow of direct benefits to people from society and the environment decline. Consequently, quality of life declines, even as economic returns increase. Increasing economic returns may further distort the SEE balance necessary for a desirable QOL. Declining QOL, in turn, may lead to increases in economic extraction from ecological and social capital stocks. People have been led to believe the solution to declining quality of life is greater short-run economic benefits. They don't realize they need to restore the balance. Thus, most feel they cannot afford to make uncertain, long-term social and ecological investments. But, the more they extract from social and ecological stocks to generate current income, the faster will be the

decline in QOL. Declining QOL, in this case, is a consequence of a self-generating deterioration of the SEE balance, rather than a deficit of economic returns.

Even if one argues that the current balance of extraction and regeneration is sustainable, there is little doubt that humanity has the ultimate ability to place demands of the ecological and social capital stocks far beyond their natural regeneration capacity. Thus, it would seem obvious that decisions regarding the balance of intentional extraction and investment must become part of the managerial process if humanity is to be sustained over time.

Ultimately, the rate of “net” ecological resource depletion must be balanced with the inflow of solar energy from the sun. According to the second law of thermodynamics, some amount of energy availability is irretrievably lost with each conversion of energy to matter and matter to energy. Sustainability ultimately requires the loss of energy availability to be no more than the net inflow of energy from the sun. Other biological species represent critical linkages between solar energy and human life. Other species may also be critical to human cultural and spiritual well being. Thus, biological diversity is essential to sustainability.

A simplified model of a sustainable economic system is shown in figure 2. This model shows the interaction of cycles of human needs, production, and maintenance of resource stocks required to sustain production and meet the needs of people. Stocks are referred to as resources rather than capital. The new paradigm represents a conscious attempt to move away from the convention of converting everything into “economic” terms, such as human capital and natural capital, instead using the more neutral term, resources.

Production capacity is interrelated with stocks of economic, social, and ecological resources and available technologies for resource use and regeneration. Investments in technology can enhance, but not replace, the ability of resources to support production and meet the needs of people. In this model, production includes all those things that contribute to quality of life -- economic, social, and ecological. The production process includes recycling and regeneration of resources as well as conversion of resources to direct human use. Wastes are directed to “sinks” for absorption, detoxification, regeneration and ultimate reentry into the productive resource base. But sink capacity, and thus, rate of regeneration, is limited. Delays in various cycles imply the existence of “chaotic” interconnections - the basic organization is stable but precise cause and effect relationships are chaotic.

A sustainable dynamic balance requires that the inflow of solar energy must match the outflow of “entropy” -- the rate at which energy loses its availability. Needs are identified as individual, shared, and spiritual in nature. This designation assumes that “old” economic needs were primarily individual -- the pursuit of self-interest. Shared needs are those needs that are not unique to any individual but must be realized collectively with some larger community of interest. Spiritual needs are the needs to fulfill one's responsibilities to humanity. These needs correspond to the economic, social, and ecological dimensions of quality of life in figure 1. Human progress is identified as an essential dynamic characteristic of human quality of life.

Figure 2. Sustainable Economic System



<u>NEEDS</u>	<u>RESOURCES</u>	<u>ALLOCATION</u>
- Individual	- Economic	- Market/private
- Shared	- Social	- Collective/public
- Spiritual	- Ecological	- Ethics/rules

Some may question the relationship between ecology and spirituality. However, investments in ecological capital may be correctly identified as stewardship. Benefits of true stewardship do not accrue to the steward, either in total or in part (Beverley and Ott). They accrue to someone else -- possibly some unknown entity(s) in some future generation in which the steward may not even have a direct descendant. Such investments are not made unless one feels some "spiritual" responsibility for the future of humanity. Spiritual satisfaction may be associated with one's religion, but it need not be. It is simply the satisfaction that comes from fulfilling the responsibilities that one "believes" are inherent aspects of being a worthy human being. Those without spirituality will see no logic in making long-run ecological investments.

To be sustainable, entropy cannot exceed the inflow of solar energy over the long run. No one has any concept of how life might be sustained on earth without the inflow of solar energy and receptive mineral and biological systems to capture and transform it into human useful form. In addition, the presence or absence of solar energy is of little human consequence if there is no context of society to give meaning to human life. The economics of sustainability must provide guidance for the holistic management of the ecological, social, and economic resources upon which long run sustainability of humanity depends.

The resource allocation process is identified only in generic terms in figure 2. Economic resources are allocated through private markets to satisfy self-interest and meet individual needs. Social resources are allocated by collective actions producing public goods and services to meet shared or community needs. Ecological resources are allocated by ethics and values, which guide voluntary acts of stewardship, as well as rules and regulations designed to ensure universal compliance. The current amalgamation of laws, which have been designed to produce public goods and services and to enforce ethics and values, will be delineated to link appropriate ends and means. A primary difference from conventional economic thinking is that private markets are not used to allocate social or ecological resources to meet needs that are fundamentally communal or spiritual in nature. Buying and selling rights to pollute makes no more sense than buying and selling one's right to think, speak, or to move about.

The task ahead is to develop a coherent set of behavioral theorems by which to guide sustainable resource management. One may be tempted to conclude that no such set of theorems can work because human greed cannot be accepted as the primary motivating force for human behavior, that economic needs must take precedent over ecological and social needs, particularly at

subsistence levels, and that human wants are insatiable. But these, and other such “truths”, are nothing more than “beliefs” of the past that are subject to challenge in the future.

Greed is a powerful human tendency, but no more so than the tendency toward violence as a means of self-fulfillment. Civilized society has rejected violence as a means by which one person may gain an advantage over another -- although we occasionally resort to violence when our efforts to behave as civilized beings fail. Greed just might be relegated to the role of violence -- once we abandon the old economic notion of the greatest greed leading to greatest good. In the quantum world, we can't measure anything without changing it. We may well have encouraged greed by measuring its consequences and praising its products.

The old theory of hierarchy of needs may be irrelevant in issues of sustainability. The choice of survival and security over satisfaction may well be short-run phenomena. A baby without love may have no more chance of surviving to adulthood than does a baby without milk. In fact a baby with enough love may be far more likely to get enough milk than is a baby with enough milk to get enough love. Many thoughtful people accept known risks to their personal security in purposeful pursuit of a higher quality of life through uncertain interactions with other people and with the forces of nature. Quality of life may well rank higher than does quantity of life.

Finally, it wouldn't matter that human wants are insatiable if we realized that quality of life is the product of a healthy balance among its economic, ecological, and social dimensions. Balance need not imply equality. A dynamic balance may imply greater or lesser emphasis on particular dimensions at different points in time -- as in the case of other living, growing organisms. However, balance implies limits with respect to inequities and some sort of averaging out over time. Problems arise when we get “too far” out of balance or stay out of balance for “too long”. When we are preoccupied with fulfilling any one -- the individual, collective, or spiritual needs of life -- we tend to lose sight of the need for balance.

We need to stop periodically to reassess and restore the balance needed to sustain a desirable quality of life. And, the pursuit of balance tends to be self-limiting. Restoring balance allows one to answer the question: “How much is enough?” When an increased emphasis on one dimension of one's life -- individual, collective, or spiritual -- causes a decline in overall quality of life, “what was-- was enough”. The process of maintaining dynamic balance in our own lives will ensure there is enough left to provide equal opportunities for those of generations to follow.

Conclusion

This paper is but a first small step on, at best, a long and difficult journey. A chapter could be written about nearly every paragraph in this text. Volumes could be written without covering all the pros and cons of the issues that have been raised. A whole new set of theorems must be developed to support a new economics of sustainability. That process was not even begun in this paper. Some of the propositions put forth undoubtedly will prove unsound. Others may be under or over-stated. Many potentially important and relevant issues have not even been raised. The whole process may prove fruitless and a total waste of time. Or it could be a first step to a “whole new world” of economics.

Should we be so bold and egotistical as to think we might develop a whole new theory of economics? Perhaps not. Perhaps, we will simply make “fools of ourselves” in the process of trying. But Susan B. Anthony once said: “Caution, careful people, always casting about to preserve their reputation and social standing, never can bring about reform. Those who are really in earnest must be willing to be anything or nothing in the world's estimation”. I also like the words of Margaret Mead who said: “Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed it's the only thing that ever has.”

It is time for a group of committed, thoughtful people, even if our number is small, to risk being anything or nothing in an attempt to “change the world”.

AFTERWARD

Initial reviewers of this paper provided several editorial corrections and comments - which have been incorporated into the manuscript. But the reviewers also raised some substantive conceptual issues. Very brief responses to these substantive issues have been added to the text of the paper. However, those responses were kept short to maintain some sense of balance among the many topics covered in the paper in total. More complete responses to the issues raised by reviewers are included in this afterward. Most of these issues were raised by more than one reviewer, indicating a need for elaboration. The intention is to incorporate the more detailed explanations into the text of a longer version of the manuscript at some later date.

Can life possibly be sustained on forever? The stated goal of sustainability is to sustain a desirable quality of human life on earth “forever”. Granted, with our limited knowledge, we cannot conceive of being able to sustain life on earth without a continuing inflow of solar energy. Thus, solar-based systems of production represent the current limit to our thinking with respect to means of ensuring sustainability. Perhaps the post-solar phase of human “life” will be spiritual rather than physical in nature. If so, this might explain why spirituality is coming into discussions of physical sustainability - to prepare humanity for post-solar sustainability. Lacking any logical endpoint, the “goal” remains: to sustain a desirable quality of human life on earth “forever”.

Will ascribing spiritual motivations to ecological concerns turn a lot of people off - particularly scientists? It probably will. However, the concept seems to ring true to a lot of thoughtful, well-educated people. And, what other explanation is there? There are obvious self-interests and community interests in dealing with environmental externalities which affect the environment today. However, there are no self-interests or community-interests - at least none in which one can share -- in decisions affecting the well being of people three to five hundred years in the future. The motivation here is simply to “do the right thing”. Interestingly, doing the right thing for future generations would lead to “economic” misallocation of resources among alternative uses and utilization of resources at less than “economic” optimum rates. Spirituality misguides the “invisible hand”.

Some will be concerned that linking spirituality with nature conflicts with organized religions, most of which link man directly to God. However, spirituality is a broad umbrella capable of embracing a wide range of worldviews. The point is not whether one's reverence for nature comes from a belief in God or one's belief in God arises from one's reverence for nature. The point is; concern for intergenerational equity - a cornerstone of sustainability - arises from a belief in things spiritual - fulfilling responsibilities for which there is no earthly reward.

A similar concern relates to whether non-human species should exist only because they are of some value to humans or because they have as much right as do humans to exist. The contention here is that economics of sustainability relates to maintaining a desirable quality of "human" life. But, the quality of human life is inseparable from that on non-human species. In addition, the relationship between humans and other species certainly is not limited to "utilitarian" or "conventional economic" relationships. When spiritual and social values are brought into economics, relationships between humans and other species become much more inclusive.

One can logically "believe" that species with no current or conceivable future "utilitarian" purpose for humans should be protected - simply because it is "the right thing for people to do". Humans may benefit from preserving other species simply because they believe protecting other species is an essential human responsibility. Also, one can be committed to following community standards for human treatment of animals, even though they seem unnecessary or unreasonable to the individual. The feelings of people concerning treatment of animals can provide sufficient motivation for concern about feelings of animals. Enlightened anthropocentricity embraces ecocentricity. The point is; economic decisions are made by humans to benefit humans. Humanity simply should not be expected to commit "intentional" acts against itself.

Why does the paper virtually ignore the issues of macroeconomic and public policy? Macroeconomics and public policy will be important dimensions of the new economics of sustainability. But they will have to be rethought and rebuilt from the ground up -- on a new theoretical foundation of economic sustainability. For example, public policies should not be used to alter market values, through taxes or subsidies, to encourage more sustainable utilization or regeneration of social or ecological resources. We don't allow people to buy others' rights to vote nor do we sell "rights" to kill someone. Thus, we shouldn't design public policy which will allow anyone to buy peoples' "rights" to equal opportunity, nor should we sell "rights" to exploit resources needed to sustain future generations.

Decisions that are social or collective in nature should be made by means appropriate for public choice, such as voting. Those things spiritual in nature should be dealt with by means appropriate to ensure fundamental rights for all, such as constitutional guarantees. Economically efficient outcomes do not ensure socially responsible or ecologically sound outcomes. Each traditional policy issue needs to be rethought. Is it economic, social, or ecological? And, it should be dealt with accordingly.

Likewise, macroeconomic policy will need to be totally redirected from the "objective" of maintaining maximum economic growth to the "purpose" of sustaining long run quality of life. Any approach that assigns pseudo-economic values to social and ecological products or

resources, and then proceeds to maximize “economic” growth, will be inadequate, if not self-defeating. The imputation of economic values may slow overall rates of resource depletion, or encourage regeneration, but allocation of those resources among competing uses will reflect economic motives, rather than social or ecological motives. Once resources are assigned economic values, they will be treated as if they are economic in nature - which they are not.

The new macroeconomics must be multidimensional in nature - with economic, ecological, and social dimensions. It must deal with balance among, as well as attainment of, things economic, social, and ecological. Thus, the new macroeconomics must be holistic, not just aggregate, in nature. It must promote the sustainability of communities, nations, and the world; as wholes, not just maximize sums of individual self-interests. It must be rebuilt upon a foundation of the new economics of sustainability.

Doesn't the old economic concept of utility include social, ecological, and spiritual values, as well as economic values? Yes, the economic concept of utility does include everything that affects the ability of a good or service to satisfy the consumer. Economists lump all “non-economic” things together and call them “tastes and preferences”. However, economic theory is based on the assumption that tastes and preferences are given or are fixed - in spite of billions of dollars spent each year on persuasive advertising designed specifically to alter tastes and preferences. Changes in prices of goods and services, incomes, wages, and other economic variables cause people, as consumers or producers, to move to higher or lower levels of overall utility or satisfaction. However, any change in utility results from changing the economic variables -- not from changes in the underlying social, ecological, or spiritual values bundled into tastes and preferences. As an analogy, lower prices or higher incomes allow consumers to climb higher up the side of a hill called “utility”. But, the hill - a mound of social, spiritual, and ecological stones - remains unchanged.

A better analogy for the economics of sustainability is to compare living with purpose to flying a plane. The old economics gives the pilot control of the throttle - a very important element of control. The throttle - like prices and income - allows the pilot to make the plane speed up or slow down. But on the old economic plane, the flaps and ailerons - like tastes and preferences -- are assumed to be in fixed positions. For any logical fixed position of flaps and ailerons the pilot can make the plane rise or fall by increasing or decreasing the speed of the plane. But, it is difficult to change directions without using the ailerons to tilt the wings and bank the plane into a turn. It is difficult also to take off or land the plane without using the flaps which allow the plane to fly at slower speeds without falling or fly at higher speeds without rising once the plane is in flight. It is not impossible to fly without flaps and ailerons nor is it impossible to fly higher and higher. But you just can't necessarily get where you want to go, and there is no way to come down short of a dangerous crash landing.

A new economics of sustainability would give the pilot flaps and ailerons, in addition to a throttle. It would help people make decisions designed to improve their social and ecological well being as well as their economic attainment. It would help people understand, and find ways to cope with, the pervasive efforts of advertisers to shape tastes and preferences in ways that serve the needs of the promoter but not necessarily the best interests of consumers. Ideally, the new economics should help people balance the economic, social, and ecological dimensions of

their lives for an “on-time take-off, a smooth flight through life's stormy skies, and to a safe landing at their ultimate destination”.

Do we need a “new economics of sustainability”, or do we just need to quite misusing or fix up the old economics? The old economics would still be a part of the new economics of sustainability. It would be used to guide decisions that are “economic” in the traditional sense - dealing with issues that are clearly self-interest in nature. But, conventional economics should not be “misapplied” by using it to deal with social and ecological issues - which clearly go beyond narrow self-interest.

Even when used appropriately, conventional economics will need to be “fixed”. A very valuable function of “free market” economics is “short run” allocation of “private” resources among competing “private” ends. No other mechanism has been found that comes close to matching the economics of self-interest in carrying out this critical role. However, conventional economics cannot perform this function efficiently unless conditions prevail that are at least somewhat analogous to those of perfect competition. No one seller or buyer can be allowed to dominate a market. Buyers and sellers must actively compete, rather than collude. Adequate, accurate information must be readily available to ensure that realizations are in line with expectations. Resources should be used to “satisfy” the wants and needs of consumers, and not to “create” wants and needs so as to increase profits of sellers. The old economics needs to be fixed. But a system built on a foundation of self-interest cannot be “fixed” to make it fit a multi-dimensional, holistic world.

We need a new economics of sustainability because the old economics is fundamentally incapable of addressing the social and ecological issues of sustainability. The old economics is like an old house that has been fixed up over and over with new paint, new siding, new roofs, added rooms, and added stories; but still has the same support structure and foundation. Now, the old beams are rotting and the foundation is crumbling. There is no way to fix it without tearing it down and starting over from the foundation up. This necessity should not be viewed as any discredit to those who have spent careers painting, roofing, and remodeling the old house. They have made due with what they had to work on -- there seemed to be no logical alternative. We all hate to see the old building come down. But, nothing lasts forever. It simply is time to rebuild.

The rebuilding process should begin with a “scholars' retreat”. A small group of people will need to spend a period time, away from distractions, focused on the purpose of sharing insights and ideas, discussing and reflecting perceptions, refining concepts in this paper and in related works, and moving toward the development of a new theory of economic sustainability.

The group should include scholars with a common grounding in economics, thus facilitating communication, but with a diversity of interests, backgrounds, and perspectives. The group should include scholars who share a commitment to changing old economic paradigms, but whose minds are open to exploring a full range of new paradigms as replacements for the old. This group of scholars will lay the foundation for a new “economics of sustainability”.

The tangible product of this retreat might be a book, a series of papers, or both. The retreat may lead to a conference, a series of conferences, a new association, all or none of these. But most

importantly, this retreat could plant the seeds that eventually would grow into a new theory of economics. Whether a new “Wealth of Nations” emanates directly from this retreat or is some distant derivative, is not the most important question. What's important is for the world to realize that the “sustainability” of the wealth of nations depends on an economic paradigm different from the one proposed by Adam Smith. The future of humanity depends upon our ultimately developing a new “economics of sustainability”.

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