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Ecological Economics: The Concept of Scale and Its Relation to Allocation, Distribution, and Uneconomic Growth

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Introduction: My discussion is in five parts. First, I look at ecological economics from the outside by summarizing the views of some scholars from other disciplines who have recently taken an interest in ecological economics and compared it quite favorably to neoclassical economics. Second, a look at the main features and issues in ecological economics, noting differences and questions under debate with mainline neoclassical economics. Third, a look at the meanings of economic growth, and the specific issue of economic growth versus uneconomic growth in the scale of the physical economy. Fourth, some policy implications from ecological economics about avoiding uneconomic growth by seeking a steady-state economy at or near the optimum scale. Fifth, I consider some alternative formulations on why optimal allocation presupposes a given scale, as well as a given distribution.

I. Ecological Economics as Viewed from the Outside—
Although neoclassical economists persist, by and large, in ignoring ecological economics, we have, nevertheless, recently received some very sympathetic attention from historians of the recent past. I cite three examples below.

- (1) J. R. McNeill, Something New Under the Sun (An Environmental History of the Twentieth Century World), W.W. Norton, New York, 2000.

"The growth fetish, while on balance quite useful in a world with empty land, shoals of undisturbed fish, vast forests, and a robust ozone shield, helped create a more crowded and stressed one. Despite the disappearance of ecological buffers and mounting real costs, ideological lock-in reigned in both capitalist and communist circles. No reputable sect among economists could account for depreciating natural assets. The true heretics, economists who challenged the fundamental goal of growth and sought to recognize value in ecosystem services, remained

outside the pale to the end of the century [these heretics are explicitly identified by McNeill as ecological economists in his footnote 21]. Economic thought did not adjust to the changed conditions it helped to create; thereby it continued to legitimate, and indeed indirectly to cause, massive and rapid ecological change. The overarching priority of economic growth was easily the most important idea of the twentieth century.” (p. 336).

- (2) Peter Hay, Main Currents in Western Environmental Thought, Indiana University Press, Bloomington, IN, 2002.

In his Chapter 8 on economic thought and the environment, Hay clearly distinguishes ecological economics from environmental economics, and devotes more space to discussing the former, including the contributions of many individual ecological economists.

“[Ecological economics] is problem-focused rather than concerned with abstract modeling, and, in contrast to conventional neo-classicism, ecological economics shifts the focus from micro to macro and relevant time frames from the very short term to deep time. Ecological economics complements the relational and synergistic realities of ecology. It is, therefore, a holistic rather than a reductionist endeavor and gives due weight to process, change and flux, rather than stasis. Such an economics also incorporates an ethical and visionary dimension—necessary because grounding economic thought within a broader and prior context requires strictures of “ought” to govern contextual relationships.” (p. 233).

- (3) Robert L. Nadeau, The Wealth of Nature: (How Mainstream Economics Has Failed the Environment), Columbia University Press, 2003.

“What the ecological economists have to say about the inherent flaws of neoclassical economic theory from an ecological perspective is, as we shall see, quite devastating, and many of their proposed economic solutions to environmental problems are carefully reasoned, beautifully conceived, and utterly appropriate. But if this is the case, why is there virtually no dialogue between the ecological economists and the mainstream economists who sit at the right hand of global planners?” (p.10)

Why indeed?

In addition to these historians, a professor of Law at Cornell University, Douglas A. Kysar, has recently given a fair hearing to ecological economics (see “Sustainability, Distribution, and the Macroeconomic Analysis of Law”, Boston College Law Review, Vol. XLIII No.1, December, 2001, pp.1-71; see also “Law, Environment, and Vision”, Northwestern University Law Review, Vol. 97, No. 2, Winter 2003, pp, 675-729.):

“This Article introduces the field of ecological economics and analyzes its potential use as a macroeconomics for legal analysis..... As will be seen the implications could be quite broad. Traditionally legal economists have given little attention to macroeconomic subject matter. If the tenets of ecological economics are to be believed, this narrowness of focus may rest on unfounded assumptions about the nature of human economic activity and its relationship to the environment. Indeed, if the ecological economic understanding of this relationship is correct, the impact of legal rules on the macroeconomy could become an issue of central concern to legal scholars.....Ecological economics offers this potential because it is built around a more complex understanding of human economic goals than traditional economic analysis” (p. 6, “Sustainability....”).

Professor Kysar then proceeds to introduce ecological economics to legal scholars with a highly competent 50-page summary of its basic ideas. One certainly wishes him success in redirecting the attention of “law and economics” away from its founding fixation on microeconomics (Chicago-style), and towards macroeconomics (ecological economics-style)!

Theologian Sallie McFague (“New House Rules: Christianity, Economics, and Planetary Living”, Daedalus, fall 2001) argues that *“a persuasive case can be made that there is an intrinsic connection between the ecological economic model and Christianity. Distributive justice and sustainability, as goals for planetary living, are pale reflections, but reflections nonetheless, of what Jesus meant by the kingdom of God.* However, *“presently Christianity is supporting the neoclassical economic paradigm to the degree that it does not speak against it and side publicly with the ecological view.”* The main problem with neoclassical economics, she argues, is that

“distributive justice to the world’s inhabitants and the optimal scale of the human economy within the planet’s economy—are considered “externalities” by neoclassical economics. In other words, the issues of who benefits from an economic system and whether the planet can bear the system’s burden are not part of neoclassical economics.” Therefore it is hard to consider neoclassical economics as even a pale reflection of the Kingdom of God. Ecological economics at least offers a better set of “house rules” for the human and biospheric community.

Since these scholars are more disinterested observers of ecological economics than are mainstream economists, I think we are justified in taking some satisfaction in their relatively favorable evaluation of our work, even if they, like us, may not be representative of the majority of their disciplines. Occasionally it is good to try to see ourselves as others see us. While it remains true that a small fraction of all economists agree with ecological economics, we must remember that the large denominator mainly responsible for the smallness of this fraction contains many economists who have never given a moment’s thought to the issues that have called ecological economics into being. If we eliminate them from the denominator as irrelevant then the fraction is not nearly so small!

II. Ecological Economics in General and Compared to Neoclassical Economics.---Ecological economics is mainly about three issues: allocation of resources, distribution of income, and scale of the economy relative to the ecosystem—especially the third. A good allocation of resources is efficient (Pareto optimal); a good distribution of income or wealth is just (a limited range of acceptable inequality); a good scale does not generate “bads” faster than goods, and is also ecologically sustainable (it could last a long time, although nothing is forever).

Allocation and distribution are familiar concepts from standard economics—for any given distribution of income there is a different optimal efficient allocation of resources with its corresponding optimal set of prices. A Pareto optimal allocation is one in which it is impossible to reallocate resources in a way that makes someone better off without making someone else worse off—a

very minimalist definition of efficiency. Standard economics focuses primarily on the allocation issue, but pays secondary attention to distribution, first because a given distribution is logically necessary for defining efficient allocation, and second because distributive fairness is important in its own right. It is fair to say, however, that ecological economists consider the issue of distributive fairness more pressing than do most neoclassical economists.

The third issue of “scale”, by which is meant the physical size of the economy relative to the containing ecosystem, is not recognized in standard economics, and has therefore become the differentiating focus of ecological economics.

Ecological economists’ pre-analytic vision of the economy as an open subsystem of a larger ecosystem that is finite, non growing, and materially closed (though open with respect to solar energy), immediately suggests several analytical questions regarding scale: How large is the economic subsystem relative to the earth ecosystem? How large could it be, i.e., what is its maximum scale? And most importantly, How large should the subsystem be relative to the ecosystem? Is there an optimal scale (less than the biophysical maximum) beyond which physical growth of the economic subsystem (even if possible) begins to cost more at the margin than it is worth, in terms of human welfare? You will not find these questions in standard economics textbooks.

If the economy grew into the Void it would encroach on nothing, and its growth would have no opportunity cost. But, since the economy in fact grows into and encroaches upon the finite and non growing ecosystem, there is an opportunity cost to growth in scale, as well as a benefit. The costs arise from the fact that the physical economy, like an animal, is a “dissipative structure” sustained by a metabolic flow from and back to the environment. This flow, called “throughput”, begins with the depletion of low-entropy, useful resources from the environment and ends with the return of high-entropy polluting wastes. Depletion and pollution are costs—“bads” rather than goods. Not only does the growing economy encroach spatially and quantitatively on the ecosystem, it also qualitatively degrades the environmental sources and sinks of the metabolic throughput by which it is maintained¹.

¹ See Nicholas Georgescu-Roegen, The Entropy Law and the Economic Process, Harvard University Press, Cambridge, MA, 1972.

The scale of the economy has two measures : (1) the throughput flow of physical resources that constitute the material component of the annual flow of goods and bads, and (2) the accumulated stock of goods in the form of wealth, and of bads in the form of “illth” (to employ a useful word coined by John Ruskin to designate the opposite of wealth). The throughput flow measure is emphasized because it is what affects ecosystem sources (depletion) and sinks (pollution) at the margin.

We would of course prefer not to produce bads or allow them to accumulate in illth, but since we live in a finite world governed by the laws of thermodynamics, and since we and the artifacts we produce are dissipative structures, we cannot avoid producing bads along with goods. If we stop depleting, we and our economy die of starvation; if we stop polluting, we die of constipation. If, however, we keep the throughput within the natural capacity of the ecosystem to absorb wastes and regenerate depleted resources, then the scale of the economy is ecologically “sustainable”. There are many sustainable scales. The particular sustainable scale that maximizes the difference between wealth and illth (i.e., equates marginal goods produced with marginal bads), is the optimal scale. If we grow beyond this point then growth becomes uneconomic, and GNP becomes, in Ruskin’s terms, “a gilded index of far-reaching ruin.”

As growth pushes us from an empty world to a full world the limiting factor in production will increasingly become natural capital, not manmade capital—e.g., the fish catch today is no longer limited by manmade capital of fishing boats, but by the complementary natural capital of fish populations in the sea; irrigated agriculture is limited not by the manmade capital of pumps and pipes, but by the natural capital of aquifers and rivers, etc. As we move from the empty world into a full world, economic logic remains the same, namely to economize on and invest in the limiting factor. But the identity of the limiting factor changes from manmade capital to remaining natural capital, and our economizing efforts and policies must change accordingly. Therefore it becomes more important to study the nature of natural capital, of environmental goods and services—are they rival or non rival, excludable or non excludable-- in order to know the extent to which they can be allocated by markets.

Ecological economics has no quarrel with the standard analysis of allocative efficiency, given prior social determination of the distribution and scale questions. Although the main difference has been the focus on scale, that difference has entailed more attention to distribution, especially to two often neglected dimensions of distribution: namely intergenerational distribution of the resource base, and distribution of places in the sun between humans and all other species (biodiversity). Also as more vital natural resources and services cease being free goods, and are allocated by the market whenever possible, the fairness of the assumed distribution underlying efficient market allocation becomes more critical.

One question sure to be asked is: What is the relation between ecological economics and the fields of resource economics and environmental economics? The difference is that the latter two are both subfields of neoclassical economics, do not consider scale an issue, have no concept of throughput, and are focused on efficiency of allocation. Resource economics deals with the efficiency of allocation of labor and capital devoted to extractive industries. It develops many useful concepts, such as scarcity rent, user cost, and Hotelling's rule. Likewise, environmental economics also focuses on efficiency of allocation and how it is disrupted by pollution externalities. Concepts of internalizing externalities by Pigouvian taxes or Coasian property rights are certainly useful and policy-relevant, but their aim is allocative efficiency via right prices, not sustainable scale. Ecological economics connects resource and environmental economics by connecting depletion with pollution by the concept of throughput². It also pays much more attention to impacts on, and feedbacks from, the rest of the ecosystem induced by economic activities that cause depletion, pollution and entropic

² Curiously the World Bank in WDR 2003, Sustainable Development in a Dynamic World, has adopted ecological economist's vocabulary of "sources" and "sinks", but does not tie them together by the concept of throughput—the entropic flow from source to sink. Much less do they consider the scale of the throughput or its entropic directionality. In dismissing the idea of overconsumption they say, "But the overall level of consumption is not the source of the problem. It is the combination of the specific consumption mix and the production processes that generates the externality. And for these there are well-established policy prescriptions from public finance" (p. 196). So much for scale—it is not important—allocative efficiency via right prices is everything!

degradation, chief among which is the growing scale of the human economy.

Within this overall context of a difference in basic vision, there are in addition some important specific issues of debate between ecological and neoclassical economists. Below I list seven important ones.

- (1) Whether natural and manmade capital are primarily substitutes or complements. Ecological economics sees them as basically complements, substitutable only over a very limited margin. Neoclassical economics regards them as overwhelmingly substitutes. If complements, the one in short supply is limiting; if substitutes, there is no limiting factor. The phenomenon of limiting factor greatly increases the force of scarcity. For example, the scarcity of fish in the sea reduces the value of complementary capital of fishing boats.
- (2) The degree of coupling between physical throughput and GNP. Ecological economics sees this coupling as by no means fixed, but not nearly as flexible as neoclassicals believe it to be—in other words, the “dematerialization” of GNP and the “information economy” will not save growth economics by forever reducing material intensity of GNP. We can certainly eat lower on the food chain, but we cannot eat recipes! While throughput per dollar of GDP has recently declined somewhat in some OECD countries, the absolute level of throughput continues to increase as GDP increases.
- (3) The degree of coupling between GNP and welfare. Here ecological economists consider the coupling very loose, at least beyond some minimum amount. Since many non economic sources of welfare are damaged by growth in GNP, yet are not subtracted from GNP, the gap between Welfare and GNP widens as we move from the empty world to the full world. Neoclassical economists invariably advocate policies based on the assumption that welfare increase is rigidly coupled to GNP growth, even though in theory they allow themselves a few doubts.----In sum, ecological economists see GNP as

tightly coupled to throughput and loosely coupled to welfare, while neoclassicals believe that GNP is only loosely coupled to throughput but tightly coupled to welfare. There is clearly room for empirical work here!

- (4) A deeper philosophical issue is the relative importance in production of “value added” versus “that to which value is added”. Value is added to the throughput flow of natural resources, and it is added by the transforming services of labor and capital. In Aristotle’s terms labor and capital are the efficient cause of production (transforming agent), while natural resources are the material cause (that which is transformed). Neoclassical economists evidently do not believe in material causation because their production functions usually say that output is a function only of labor and capital inputs—a recipe that includes the cook and her kitchen, but no list of ingredients. When they occasionally do include resources as an input in the production function, they almost always do it in a way that contradicts the first law of thermodynamics³.

This error is repeated with admirable logical consistency in national income accounting where GNP is defined as the sum of all value added by labor and capital. No valuable contribution from nature is recognized. Natural resources in the ground are of zero value. When extracted they are valued by the marginal cost of capital and labor needed to extract them. Yes, there are royalties paid to resource owners, and that

³ That is, as a multiplicative form that analytically describes the process of production as the multiplication of capital times labor times resources (each factor is raised to an exponent, but that is not important to the point I am making). In this representation we can hold output constant and reduce resources as much as we wish (though not to zero), as long as we increase labor or capital by the required amount. We can supposedly make a hundred-pound cake with only five ounces of flour, sugar, eggs, etc., if only we stir hard enough, and bake in a big enough oven! In mathematics a “product” is yielded by multiplying “factors”. In production there is no multiplication, only transformation of resources (material cause) by labor and capital (efficient cause) into a final good. Have we been misled by the mathematical terms of “factors” and “products” to see a process of multiplication where there is none?

seems like a price for resources in the ground, but royalties are determined by savings on labor and capital costs of extraction whenever the owner's mine or well is richer or more accessible than the marginal mine or well. Resources are considered a free gift of nature, but some free gifts are easier to unwrap than others, and earn a rent determined by their relative ease of "unwrapping" or extraction, as measured by labor and capital costs saved. Labor and capital remain the source of all value, nothing is attributed to nature.

Ecological economics recognizes that it is a lot easier to add value to low-entropy natural resources than to high-entropy waste, and that this extra receptivity to the addition of value by labor and capital should count as "nature's value value added". Low-entropy matter/energy is our ultimate means without which we cannot satisfy any of our ends, including that of staying alive. We cannot produce low entropy in net terms, but only use it up as it is supplied by nature. It is scarce and becoming more so. To omit this necessary contribution from nature both from our theory of production and from our accounting of value is a monumental error.

- (5) Growth has been treated as a macroeconomic issue, and frequently justified in terms of GNP accounting. If macro policies are designed to promote growth in GNP, then ex post accounting issues become relevant to ex ante policy in the next time period. Ecological economists have argued that whole categories being measured in GNP are mistakenly conceived, even if the prices by which the value of the category is measured are correct. I consider three such category mistakes in GNP accounting in the next section.
- (6) Although ecological economics focuses on the physical or real economy, monetary issues are also relevant. Under our current fractional reserve banking system, favored by the neoclassical mainstream, the money supply is a by-product of private commercial activities of

lending and borrowing, rather than a public utility for effecting exchange. Over 95% of our money supply is created by the private banking system (demand deposits) and bears interest as a condition of its existence. Unless loans are repaid at interest and renewed, the money supply will shrink and transactions will be more difficult. Fractional reserve money is therefore not neutral with respect to the scale of the physical economy—it requires growth of GDP to keep the money supply from declining. And GDP growth correlates positively with throughput growth. Furthermore the seigniorage (profit to the issuer of fiat money) now goes largely to the private sector (banks and their customers), rather than to the public sector, the government, the legitimate supplier of the public utility of money. A public good has been subjected to “enclosure”— converted to a private good— just like the common pastures of England. Ecological economists also welcome the local reclaiming of money as a public utility by the various supplementary local currency movements. Local currencies allow people, especially in depressed areas, to make local exchanges (to employ each other) without first having to compete or be employed in the national economy just to get the money that allows them to avoid the enormous inconvenience of even local barter. Also seigniorage from local money can be used to finance local public goods.

(7) Ecological economists' preference for the local is also expressed by its advocacy of internationalization and opposition to the globalization so favored by neoclassicals. Internationalization refers to the increasing importance of relations between nations: international trade, international treaties, alliances, protocols, etc. The basic unit of community and policy remains the nation, even as relations among nations, and among individuals in different nations, become increasingly necessary and important. Globalization refers to global economic integration of many formerly national economies into one global economy, by free

trade, especially by free capital mobility, and also, as a distant but increasingly important third, by easy or uncontrolled migration. Globalization is the effective erasure of national boundaries for economic purposes. As nations encounter limits to the scale of their national economies they seek to grow into the global commons, and into the ecological space of other nations. Global integration is an attempt by all economies to expand their national scale simultaneously. Global boundaries are of course not erased, and the result is that all countries now integrated will hit the limits to growth more simultaneously and less sequentially than before, with less opportunity to learn from the experience of others.

There are other issues, of course, but these seven illustrate the range and importance of the differences, and provide a research agenda for at least several years.

III. Economic Growth and Uneconomic Growth.---
Economic growth is the major goal of most countries today. But what exactly do we mean by economic growth? Usually growth in GNP. But is economic growth so measured a holy icon of the summum bonum, or a statistically graven image of Mammon? It can be either because there are two very different meanings of economic growth in common usage, often confused, and certainly conflated in the measure of GNP:

(1) “Economic growth” in sense (1) is simply the expansion of what we call “the economy”, i.e., production and consumption of goods and services. The economy is basically the human niche within the ecosystem, what we have called its scale. It is measured either by the stock of people and their artifacts, or by the flow of resources necessary to maintain and add to this stock. That, in physical terms, is the economy. When it gets bigger in scale we have growth of the economy, and refer to it in quite normal English usage as “economic growth”.

(2) “Economic growth” in sense (2) is any change in the economy for which extra benefits are greater than extra costs. Benefits and costs are not physical concepts, but refer to psychic experiences of increased or decreased welfare or enjoyment of life.

The changes in the economy that cause changes in costs and benefits may themselves be either physical or nonphysical. Whatever profits us, whatever yields net benefits, is “economic growth”. In public discourse we shift easily from one meaning of “economic growth” to the other, and thereby introduce a lot of confusion. Quantitative increase in size and qualitative improvement in wellbeing are very different things, and should not be lumped together, as done in calculating GNP.

As discussed earlier, there are three economic problems (allocation, distribution, and scale), not just one (allocation). Let us consider each in its relation to the two meanings of economic growth.

Economic growth as physical expansion of the economy (sense 1) clearly refers to the third problem (scale). Economic growth occurs when the economy gets physically larger, as measured either in its stock or flow dimensions. Since the economy grows into the rest of the finite ecosystem, not into the infinite Void, the economy becomes larger not only absolutely, but relative to its enveloping ecosystem. That is what is meant by scale increase, the first of the two common senses of “economic growth.” The second sense of “economic growth”—an increase in net benefit—may or may not result from growth in the first sense. More on that later.

Net benefit can result from an improvement in allocative efficiency— redirecting the same scale of resource use from low-value uses to high-value uses—this is economic growth in sense (2), but not in sense (1). Ecological economists have no problem with this kind of growth. But GNP does not distinguish growth based on greater allocative efficiency from growth based on larger scale⁴.

Let us turn now from scale and allocation to distribution—what is the relation of distribution to economic growth? Redistribution does not involve growth in sense (1)—scale stays the same. But does it involve economic growth in sense (2)—an improvement in net benefit? It does not involve a Pareto improvement because someone is made worse off in any

⁴ Indeed, GNP does not reflect efficiency very well. Greater efficiency by itself leads to lower cost and lower price. This would by itself reduce GNP, unless the quantity sold of the good increases sufficiently to offset the price decline—i.e. unless the demand for the good were elastic. Similarly, a fall in efficiency and an increase in price for a good with inelastic demand will perversely register an increase in GNP.

redistribution, so neoclassical economists would disallow redistribution as a source of net social benefit.

But Vilfredo Pareto was not God, and many people, including some economists, think it perfectly reasonable to say that a dollar redistributed from the low marginal utility uses of the rich to the high marginal utility uses of the poor increases total social utility—i.e., signals an increase in net social benefit (economic growth in sense (2)).

The conclusion is inescapable if we assume the law of diminishing marginal utility, and the democratic principle that everyone's utility counts equally. Carried to its extreme this argument implies complete equality in the distribution of income, which is why many economists backed off from it. But principles need not be carried to extremes. For that matter, the Pareto principle has its own extreme—one person could have all of the surplus and everyone else live at subsistence (or die for that matter!), and there would still be no case for arguing that redistribution would increase net social benefit. Within limits, therefore it is reasonable to say that redistribution can give us economic growth in sense (2), but not in sense (1)—another reason why ecological economists pay more attention to distribution than do neoclassicals.

Does economic growth in sense 1(scale) imply economic growth in sense 2 (net benefit)? No, absolutely not! Growth in the economy, sense (1) (expansion), can be economic growth in sense (2) (net benefit), but does not have to be. It can be, and in some countries probably already is, “uneconomic growth”—physical expansion that increases costs by more than benefits, thus reducing net benefit. Or, to recall John Ruskin’s more colorful language, the economy becomes a net producer of “illth”, not wealth, and GNP becomes “a gilded index of far-reaching ruin”. I think this is more than a logical possibility—it is a reasonable characterization of the actual state of affairs in some countries.

One will surely ask: What makes you think that growth has become economic, say in the US ? Some empirical evidence is referenced below,⁵ but an equally fair question is to ask what makes

⁵ For critical discussion and the latest revision of the ISEW, see, Clifford W. Cobb and John B. Cobb, Jr., et al., The Green National Product, University Press of America, New York, 1994. For a presentation of the ISEW see Appendix of For the Common Good, H. Daly and J. Cobb, Boston: Beacon Press, 1989; second edition

economists think that benefits of growth are greater than costs at the current margin? GNP measures only benefits and not costs. Moreover GNP accounting commits several category mistakes—mistakes that count as benefits what are in fact costs. Three examples are discussed below.

Regrettably necessary defensive expenditures are what national income accountants call those expenditures we make to defend ourselves from the unwanted side effects of production and consumption by others. To escape the congestion and pollution of the city one buys another car and more gasoline to commute from the suburbs. This is a voluntary expenditure, but regrettable. Alternatively, one can remain in the city and regrettably spend more on soundproof windows, security services, and air filters. Regrettably necessary defensive expenditures are more coerced than voluntary, even though they are, strictly speaking, voluntary in the sense that no one had a gun at your head. Some reject such a distinction, arguing that all expenditure is defensive—food defends us against hunger, clothes defend us against cold, etc. True, but hunger and cold are not the consequences of other peoples' production and consumption—they are natural background default conditions. Defensive expenditures are "anti-bads" rather than goods. They counteract or neutralize the negative effects of other production. They should be counted as a cost of production of the activity that made them necessary, thereby increasing the price and reducing the amount purchased of that activity, and reducing scale. Instead we count them as purely voluntary purchases and add them to GDP. This may be economic growth in sense 1(expansion), but not in sense 2 (net benefit).

Monetization of previously non monetized production. A young colleague told me that he and his wife must make more money so that they can pay the woman who looks after their children enough to enable her to pay someone to look after her children while she is caring for theirs, etc. Childcare, housekeeping,

1994. See also Clifford W. Cobb, et al., "If the GDP is Up, Why is America Down?", Atlantic Monthly, October, 1995; Manfred Max-Neef, Economic Growth and Quality of Life: A Threshold Hypothesis, Ecological Economics, 15, (1995), pp. 115-118; Phillip A. Lawn, Toward Sustainable Development (An Ecological Economics Approach), Lewis Publishers, Boca Raton, FL, 2001; Clive Hamilton, Growth Fetish, Allen and Unwin, NSW, Australia, 2003.

cooking, and other household production used to be non monetized. Now they have largely been shifted to the monetary sector and thus counted in GDP. Simply counting what was previously uncounted, even though it existed, is likely not to be economic growth in either sense (1) or (2).

Counting consumption of capital as income. Running down stocks of natural capital reduces future capacity to produce, even while increasing current consumption. Depleting nonrenewables is like running down an inventory without replacing it; consuming renewable stocks beyond sustainable yield is like failing to maintain and replace depreciating machinery. The same applies to failure to maintain social overhead capital such as roads, bridges, etc. Some would consider the costs of dishonesty, whether Enron or local robbery, as the cost of having allowed the depletion of traditional social standards of honesty, or “moral capital”. Mis-counting capital consumption as income increases economic growth in sense (1), but not in sense (2), at least in the long term.

The above cases are examples of uneconomic growth in GNP even with correct prices—they involve accounting category mistakes⁶ rather than measurement errors—counting intermediate

⁶ My favorite personal experience with a category mistake occurred in Federal District Court in New Orleans concerning a Corps of Engineers cost-benefit study being used to justify dredging deep canals in the marshlands along Louisiana coast. One category of benefit was “hurricane refuge benefits” for submersible drilling rigs in the Gulf of Mexico. The rigs, it was argued, could henceforth ride out hurricanes in the now deeper inland canals of nearby Louisiana, rather than be transported all the way to Texas. That transport savings was a significant part of total benefits of canal dredging. It sounded logical until the plaintiff pointed out that submersible drilling rigs were designed to withstand hurricanes, and the last thing you would want to do if there were a hurricane in the forecast would be to move one anywhere--neither to Texas nor Louisiana. Therefore inclusion of such a benefit was spurious, a category mistake. The lawyers for the Corps kept saying, “if you disagree with our numerical estimate, give us your estimate”. The plaintiff replied that the number would obviously be zero, no calculation required, because it was a category mistake, not an error of measurement. The defense did not, or pretended not, to understand. The plaintiff lawyer clarified: “you might as well count hurricane refuge benefit for whales as a category of benefits and claim to be saving all the world’s whales. If you tell me that whales do not need hurricane refuge, then I will tell you that neither do submersible drilling rigs. It is not a matter of miscalculation—it is a category mistake.” Even the judge seemed to have a hard time understanding this, so the example is probably worth recounting. The judge eventually did understand and disallowed the hurricane refuge benefits. Curiously the Corps of Engineers redid their cost-

as final production, counting traditional but newly monetized production as if it were new production, and treating capital drawdown as if it were income. Each of these categories may be priced correctly, but the categories are misused. A job not worth doing is not worth doing well.

More convincing to me than empirical measures, which I along with others have attempted, is the simple theoretical argument that as the scale of the human subsystem (the economy) expands relative to the fixed dimensions of the containing and sustaining ecosystem, we necessarily encroach upon that system and must pay the opportunity cost of lost ecosystem services as we enjoy the extra benefit of increased human scale.

As rational beings we presumably satisfy our most pressing wants first, so that each increase in scale yields a diminishing marginal benefit. Likewise, we presumably would sequence our takeovers of the ecosystem so as to sacrifice first the least important natural services. Obviously we have not yet begun to do this because we are just now recognizing that natural services are scarce. But let me credit us with capacity to learn. Even so, that means that increasing marginal costs and decreasing marginal benefits will accompany growth in human scale. At some point increasing marginal cost will equal declining marginal benefit. That is the optimum scale. Beyond that point growth becomes uneconomic in sense (2)—the economy becomes a net producer of a current flow of bads and an accumulating stock of illth.

If we add to the limits of finitude and non growth of the total system the additional limits of entropy and ecosystem complexity, then it is clear that the optimal scale will be encountered sooner rather than later. Additionally, if we expand our anthropocentric view of the optimum scale to a more biocentric view, by which I mean one that attributes not only instrumental but also some degree of intrinsic value to other species, then it is clear that the optimal scale of the human presence will be further limited by the duty to reserve a place in the sun for other species, even beyond what they “pay for” in terms of their instrumental value to us. “Biodiversity” is an empty slogan unless we are willing to limit human scale. And of course the whole idea of “sustainability” is that

benefit analysis eliminating this mistaken benefit, but discovered an overlooked benefit whose inclusion resulted in exactly the same required cost-benefit ratio as was originally (mis)calculated!

the optimal scale should exist for a very long time, not just a few generations. Clearly a sustainable scale will be smaller than an unsustainable scale. For all these reasons I think that, for policy purposes, we do not really need exact empirical measures of the optimal scale.

Consider a thought experiment. Imagine an economy in which all prices were right—at the initial scale of the economy air and water are free goods so their right price is zero. Now suppose scale increases—population and per capita resource use both triple, so scale goes up nine-fold (roughly what has happened in my lifetime). Now air and water are scarce, so their right prices are no longer zero, but positive numbers, which are, let us assume, accurately set. In both cases right prices give us a Pareto optimal allocation and the neoclassical economist is happy. But are people indifferent between the two cases? Should they be? Some will agree with John Stuart Mill that:

"It is not good for a man to be kept perforce at all times in the presence of his species....Nor is their much satisfaction in contemplating a world with nothing left to the spontaneous activity of nature; with every rood of land brought into cultivation....every flowery waste or natural pasture plowed up, all quadrupeds or birds which are not domesticated for man's use exterminated as his rivals for food, and every hedgerow or superfluous tree rooted out, and scarcely a place left where a wild shrub or flower could grow without being eradicated as a weed in the name of improved agriculture."

To bring Mill up to date we need only extend the predicament of the wildflower to the traditional agricultural crops that replaced it. These crops are now in danger of being eradicated by their genetically engineered cousins, designed to grow faster be more resistant to both pests and pesticides.

The difference between Mill's view and that of his opposites, such as Julian Simon and Peter Huber, runs deep. Some will consider Mill old fashioned and agree with Huber, who says:

"Cut down the last redwood for chopsticks, harpoon the last blue whale for sushi, and the additional mouths fed will nourish additional human brains, which will soon invent ways to replace blubber with olestra and pine with plastic. Humanity can survive just fine in a planet-covering crypt of concrete and computers....

*There is not the slightest scientific reason to suppose that such a world must collapse under its own weight or that it will be any less stable than the one we now inhabit.*⁷ Huber does admit that such a world might not be as pretty, but it is clear that on balance he likes it better than Mill's world.

Neither side will be comforted by the neoclassical economist pointing out that in both cases right prices will give us a Pareto optimal allocation. Some will want a larger scale, some a smaller—but it seems that only the neoclassical economist is indifferent.

Some say that it is idle to talk about maintaining a steady state at some limited scale unless we first know the optimal scale at which to be stable. On the contrary, unless we first know how to be stable, it is idle to know the optimal scale. Such knowledge would only enable us to recognize and wave goodbye to the optimal scale as we grew through it! If one jumps from an airplane one needs a parachute more than an altimeter.

IV. Towards Policy ---So let us begin to search for some parachutes to arrest the free-fall of growth in scale.

We measure growth of the macroeconomy by GNP. Does that measure reflect economic growth in sense (1) (scale) or in sense (2) (net benefit)? As we have seen it conflates the two. But by historical design and intention it mainly reflects sense (1), growth in the physical scale of aggregate production. However, economists soon began to treat GNP also as a measure of growth in sense (2), any change yielding net benefits. They reasoned that for something to count in GNP, someone had to buy it, and consequently that person must have judged that the item benefited her more than it cost her, so its production must represent economic growth in sense (2) as well as in sense (1). Consequently, for most economists the concept of “uneconomic growth in GNP” makes no sense. There is no separate problem of scale. The free market is thought to optimize scale and allocation simultaneously⁸. Presumably you could temporarily have uneconomic growth in the scale of the economy (sense 1), but if it were truly uneconomic growth (sense 2), it would cost people more than it was worth and they would learn not buy

⁷ Hard Green: Saving the Environment from the Environmentalists (A Conservative Manifesto by Peter Huber, Basic Books (A Manhattan Institute Book), 2000, p.81.

⁸ In spite of the fact that mathematicians tell us that we cannot maximize a function for more than one variable!

it, and therefore it would not be counted in GNP, and whoever was making it would go out of business, and scale would decline.

This individualistic, consumer-sovereign judgment of costs and benefits has its obvious strengths, but also some less obvious weaknesses. It assumes that individual costs and benefits coincide with social costs and benefits—in other words that the prices faced by the consumer are a good measure of opportunity cost, not just to the individual consumer, but to society as a whole. However, our economy has a bias toward privatizing or internalizing benefits and socializing or externalizing costs, in the interest of maximizing private profits, thus driving a wedge between private and social.

Collecting and selling poisonous mushrooms no doubt has greater social costs than benefits. But if the costs fall on the public who cannot distinguish poisonous from non poisonous varieties, while the benefits all accrue to me, then I will find the activity privately profitable. Frequently the prices individuals pay are an underestimate of full social opportunity cost, so it is true that much stuff is purchased only because the prices are wrong—too low. Therefore some growth in GNP is uneconomic due to wrong prices. The economists' answer is admirably straightforward —get the prices right! I certainly agree. But note that getting prices right does not mean that GDP can grow forever—it means that growth as measured by GDP based on right prices would presumably have stopped sooner, when it became uneconomic—when it began to cost more than it was worth as measured by corrected prices--when the price of my poisonous mushrooms was high enough to pay wrongful death claims to my customers' survivors. By then I would be out of business. Right prices are all to the good. However, whether right prices are by themselves sufficient to avoid uneconomic growth requires further consideration.

Indifference to scale is only one neoclassical reaction. Somewhat contradictorily neoclassical economists frequently argue that scale will automatically be optimized along with allocation. The first view, indifference to scale, is logically consistent with neoclassical theory, but inconsistent with the facts (people are not indifferent to scale). The second view, that scale is automatically solved along with allocation, is either logically inconsistent or requires absurd premises to be consistent.

Regarding the second view, it is inconsistent for neoclassicals to claim that the same set of prices that optimizes allocation would

also optimize scale. That would sin against the mathematical condition that we cannot maximize simultaneously for two independent variables, as well as against Jan Tinbergen's policy rule that for every independent policy goal we need a separate policy instrument. If we use relative prices to solve the allocation problem, we cannot simultaneously use prices to solve the scale problem (or the distribution problem).

The only way out of this logical difficulty is to claim that the allocation and scale problems are not independent, but merely the same problem. The way to reduce scale to allocation is to assume that scale is total. Everything is economy, nothing is environment. Everything in creation, every whale and every amoeba, is conceptually yoked to pull the human wagon, and their services are allocated according to pecuniary calculation of present value maximization. The scale of the economy would not be a separate issue because there is nothing that is external to the economy. This is the result of carrying the principle of internalization of costs and benefits to its extreme. When everything is internalized, then nothing is external, the scale of the economy is 100% by definition.

One of the saving graces of neoclassical economists has been their humility when faced with the information requirements of a centrally planned economy. The information requirements of "centrally planning" the entire biosphere, even with liberal use of markets, is so utopian that honest neoclassicals will blush at the very thought.

Given prior social decisions on scale and distribution, the market can, as always, determine allocatively efficient prices. Indirectly these prices would then reflect socially imposed scale and distributive limits and therefore may be thought of as, in a sense, "internalizing" the values of sustainability and justice that have been previously decided politically, independently of prices.

Another way to make the point is to distinguish price-determining from price-determined policy actions. Allocation is price-determined. Distribution and scale are, or should be, price-determining. What then determines distribution and scale? Social values of justice and of sustainability. Once these social values are reflected in constraints on the market, then the allocative prices calculated by the market will reflect, and in a sense "internalize" these external constraints. We cannot use these corrected allocative prices to calculate the cost and benefit of a change in scale or

distribution, because we first had to set the distribution and scale to get the corrected allocative prices.

The way to get prices to reflect the values of just distribution and sustainable scale is to impose quantitative restrictions on the market that limit the degree of inequality in distribution of income and wealth to a just range; and that limit the scale of physical throughput from and back to nature to a sustainable volume. These imposed macro scale limits reflect the social values of justice and sustainability, which are not personal tastes and cannot be reflected in the market by individualistic actions. The market can, however, recalculate allocative prices that are consistent with the imposed scale and distribution constraints, thereby in a sense “internalizing” these social values into prices. Scale and distribution limits are our ‘parachutes’. Allocative prices are more like an altimeter.

Finally it is worth emphasizing a general policy consequence of these considerations: namely, “frugality first, efficiency second”. By frugality I mean limiting scale by limiting quantity of throughput. Limited throughput will drive up resource prices (the rents can be captured as public revenue and used to finance the reduction of other taxes). Higher resource prices will induce greater efficiency. If on the other hand we continue to follow the usual policy of “efficiency first” we do not induce frugality as a secondary consequence. Instead, efficiency improvements make frugality less necessary. A more efficient car is equivalent to discovering more oil. It will have the same consequence, namely reducing the price of oil. That will induce more use of oil than before. True, the oil will be burned more efficiently, but more will be used. We will have become more efficient and less frugal. We must become more frugal. If we seek frugality first by limiting scale, we will get efficiency as a bonus.

Standard economics strains out the gnat of allocative inefficiency while swallowing the twin camels of unjust distribution and unsustainable scale. As distribution becomes more unjust big money buys political power and uses it to avoid any redistribution. A favorite political ploy for avoiding redistribution is to emphasize economic growth. Growth in sense (1) leads to an unsustainable scale and uneconomic growth in sense (2). But if growth is uneconomic then it makes us poorer, not richer. Growth is then no longer the cure for poverty and cannot substitute for redistribution. Consequently, the concepts of uneconomic growth, accumulating

illth, and unsustainable scale have to be incorporated in economic theory if it is to be capable of expressing what is happening in the world. This is what ecological economists are trying to do.

V. Some Additional Thoughts and Alternative Formulations--Ecological economics claims that sustainable scale and fair distribution are both problems whose solutions are logically prior to determining efficient allocation. Scale determines what is scarce and what is free. Distribution determines who owns what is scarce. Only after these two issues have been determined is the market able to effect exchanges, determine prices, and allocate resources efficiently. Economists have long accepted that an optimal allocation of resources (Pareto optimum) with its resulting set of prices, requires a given distribution of income. In other words, there is a different Pareto optimal allocation for each possible distribution of income. Efficiency is only defined with reference to a given distribution of income. This point is not in dispute.

But does a Pareto optimal allocation assume a given scale as well as a given distribution? That is a disputed question—ecological economists say yes; neoclassical economists seem to say no-- to the limited extent they have thought about it in view of their traditional neglect of scale. As discussed, it would seem very inconsistent for neoclassicals to claim that the same set of prices that optimizes allocation would also optimize scale.

And there are further problems. If we take the concept of scale literally, as in the scale model of a house, to mean a proportional change in all linear (scalar) dimensions, then we might say that a scale change is simply an increase or decrease in which all proportions remain constant. All relative quantities would also remain constant. But even so an increased scale would change relative scarcities because the marginal utilities of different goods decline at different rates.⁹ Nevertheless, as long as the proportions

⁹ The marginal utility curves for different goods drop off at different rates. Even though the world is happy at an exchange rate of 5 bananas to 1 coconut, if we double the world's supply of both, people might tire of coconuts faster than they do of bananas. So the price of coconuts might fall, to 4 bananas, say. Even though the relative *proportion* of bananas and coconuts in the world has remained the same, the relative scarcity of the two has not. All of which is to say that even if you could scale things up linearly (which is not possible), prices would still change! So too would the allocation. In other words, an efficient allocation presupposes a given scale.

are right the absolute size doesn't matter. This seems to be what standard economists often have in mind. Growth can go on forever as long as the proportions are right—allocation is all, scale is nothing (see footnote 3 again).

But is it possible to have everything grow in proportion? No, for two reasons. First, if something is fixed, then it obviously cannot grow proportionally to everything else. What is fixed from the ecological economist's perspective is the size of the total ecosystem. As the economic subsystem grows, albeit proportionally in terms of its internal dimensions, the ecosystem itself does not grow. The economy becomes larger as a proportion of the total system—what we have called an increase in its scale. Natural capital becomes more scarce relative to manmade capital. That fact has enormous consequences, especially if natural and manmade capital are more complementary than substitutable—as ecological economists, contrary to standard economists, believe is the case.

The second difficulty, long noticed by biologists and some economists, is that if you scale up anything (increase all linear dimensions by a fixed factor), then you will inevitably change the relative magnitudes of nonlinear dimensions. Doubling length, width and height will not double area—it will increase area by a factor of four, and will increase volume by a factor of eight. Biologists have long noted “the importance of being the right size”. If a grasshopper were scaled up to the size of an elephant it could not jump over a house. It would not even be able to move, because its weight (proportional to volume) would have increased by the cube, while its strength (proportional to cross sectional area of muscle and bone) would have increased only by the square of the scale factor.

Returning to our example of a house, doubling the scale will increase surfaces and materials by four-fold, and volumes to be heated, cooled, and supported by eight-fold. Relative demands, scarcities, and prices of resources cannot remain the same. So the answer to our question, Does the notion of Pareto optimal allocation assume a given scale as well as a given distribution, appears to be “yes”. Scale cannot increase ‘in proportion’ because (a) there is a fixed factor, namely the size of the total ecosystem, (b) it is mathematically impossible even for all relevant internal dimensions of the subsystem to increase in the same proportion, and (c) even if quantities of all commodities could increase proportionally their

relative prices would still change because marginal utilities decline at different rates for different goods. A different scale requires a different set of relative prices to be Pareto efficient.

If we recognize the importance of scale, and want to calculate the optimal scale, how do we do it? Can we measure the cost and benefit of a change in scale by the metric of prices? The initial allocative prices, even correct prices, to be used in the calculation depend on the given, initial scale. We cannot know what new prices would correspond to optimal scale unless we already know the optimal scale. But it is exactly the optimal scale that we were trying to calculate! It is circular to calculate the optimal scale on the basis of equating marginal costs and benefits measured by prices, which assume that we are already at the optimal scale to begin with. Known initial prices correspond to the initial scale, and would be different at any other scale, including the optimal scale. To correct those initial prices to reflect the conditions of an optimal scale requires that we already know the optimal scale from independent considerations.

Furthermore, and more basically, the prices under consideration are tools for solving the problem of efficient allocation. Prices, exchange values, are simply not the relevant metric for measuring costs and benefits in terms of justice (distribution), or sustainability (scale). Prices are specific tools for attaining allocative efficiency. They are not adequate to the separate and higher level problem of determining optimal trade-offs among allocative efficiency, distributive justice, and sustainable scale. The circular reasoning encountered when this attempt is made is a symptom of a basic conceptual confusion.

If in the name of perfect internalization we insist that prices should optimally balance the “external” costs and benefits of different scales, why not likewise insist that prices should optimally balance the costs and benefits of different distributions? We would run into the same problem of circularity. If we tried to use prices based on a given distribution as the means of measuring the costs and benefits of a change in distribution in order to calculate the optimal distribution, we are again being circular—assuming we know the optimal distribution in advance. Here economists have clearly recognized the circularity and insisted that just distribution is one thing, efficient allocation is another. They do not appeal to “perfect information” and advocate raising the price of things poor

people sell, or lowering the price of things poor people buy, in order to internalize the external cost of poverty into prices¹⁰. Instead they say redistribute income directly to attain a more just distribution, and let prices adjust to attain a new efficient allocation subject to the new distribution. They do not always say this loudly enough, but they do say it. Ecological economists insist on the same logical treatment for scale as for distribution.

We need some metric of benefit and cost other than prices, other than exchange value, other than ratios of marginal utilities. As already suggested this metric is the value of justice in the case of distribution; it is ecological sustainability, including intergenerational and interspecies justice, in the case of scale. These are collective values, not individual preferences. If we follow mainstream economists in reducing all value to the level of aggregated subjective personal taste, then we will not be able to capture or bring to bear on the market the real weight of objective social values, such as distributive justice and ecological sustainability. Value transcends subjective individual preferences. Economists need to (re)learn this.

¹⁰ To do so would be to return to the “just price” doctrine of the middle ages.