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STEADY-STATE ECONOMICS

By Herman Daly

Chapter 5: A Catechism of Growth Fallacies

The part played by orthodox economists, whose common sense has been insufficient to check their faulty logic, has been disastrous to the latest act.

J. M. Keynes (1936)

The first question asked of any critic of the status quo is: What would you put in place? In place of the growth economy we would put a steady-state economy. But such a theoretical alternative is not of great interest unless there is dissatisfaction with the business-as-usual growth economy. If you have eaten poison, it is not enough to simply resume eating healthful foods. You must get rid of the specific substances that are making you ill. Let us, then, apply the stomach pump to the doctrines of economic growth that we have been force-fed for the past four decades. Perhaps the best way to do that is to jump right into the growth debate and consider critically some fifteen to twenty general pro growth arguments that recur in various guises and either expose their errors or accommodate their valid criticisms.

First a preliminary point. The verb "to grow" has become so overladen with positive value connotations that we have forgotten its first literal dictionary denotation, namely, "to spring up and develop to maturity." Thus the very notion of growth includes some concept of maturity or sufficiency, beyond which point physical accumulation gives way to physical maintenance; that is, growth gives way to a steady state. It is important to remember that "growth" is not synonymous with "betterment."

Can't Get Enough of That Wonderful Stuff

The American people have been told by no less an authority than the President's Council of Economic Advisors that, "If it is agreed that economic output is a good thing it follows by definition that there is not enough of it" (Economic Report of the President, 1971, p. 92). It is evidently impossible to have too much of a good thing. If rain is a good thing, a torrential downpour is, by definition, better! Has the learned council forgotten about diminishing marginal benefit and increasing marginal costs? A charitable interpretation would be that "economic" output means output for which marginal benefit is greater than marginal cost. But it is clear from the context that what is meant is simply real GNP. Perhaps this amazing non sequitur was just a slip of the pen. At another point in the same document the council admits that "growth of GNP has its costs, and beyond some point they are not worth paying" (p. 88). However, instead of raising the obvious question--What determines the optimal point and how do we know when we have reached it?--the council relapses into non sequitur and quickly closes this dangerous line of thinking with the following pontification: "The existing propensities of the population and policies of the government constitute claims upon GNP itself that can only be satisfied by rapid economic growth" (p. 88). Apparently, these "existing propensities and policies" are beyond discussion. This is growth mania.

The theoretical answer to the avoided question is clear to any economist. Growth in GNP should cease when decreasing marginal benefits become equal to increasing marginal costs. But there is no statistical series that attempts to measure the cost of GNP. This is growth mania, literally not counting the costs of growth. But the situation is even worse. We take the real costs of increasing GNP as measured by the defensive expenditures incurred to protect ourselves from the unwanted side effects of production and add these expenditures to GNP rather than subtract them. We count real costs as benefits. This is hypergrowthmania. Obviously, we should keep separate accounts of costs and benefits. But to do this would make it clear that beyond some point zero growth would be optimal, at least in the short run. Such an admission is inconvenient to the ideology of growth, which quite transcends the ordinary logic of elementary economics. More precisely, it is good growthmanship strategy to admit the theoretical existence of such a point way out in the future, but somehow it must always be thought of as far away. The ideological reasons for this are clear and have to do with the problem of distribution of output in an economy in which ownership of land and capital is highly concentrated and embodies laborsaving technology. Full employment at a living wage requires high aggregate demand, which requires high net investment to

offset the large savings made possible by concentrated income. High net investment signifies rapid growth.

The Hair of the Dog that Bit You

One of the most popular arguments against limiting growth is that we need more growth in order to be rich enough to afford the costs of cleaning up pollution and discovering new resources. Economist Neil Jacoby says, "A rising GNP will enable the nation more easily to bear the costs of eliminating pollution" (1970, p. 42). Yale economist Henry Wallich makes a similar point:

The environment will also be better taken care of if the economy grows. Nothing could cut more dangerously into the resources that must be devoted to the Great Cleanup than an attempt to limit resources available for consumption. By ignoring the prohibitionist impulse and allowing everybody to have more, we shall also have more resources to do the environmental Job [Wallich, 1972 p. 62].

No one can deny that if we had more resources and were truly richer, all our economic problems would be more easily solved. The question is whether further growth in GNP will in fact make us richer. It may well make us poorer. How do we know that it will not, since we do not bother to measure the costs and even count many real costs as benefits? These critics simply assume that a rising per-capita GNP is making us better off, when that is the very question at issue!

If marginal benefits of physical growth decline while marginal costs rise (as elementary economic theory would indicate), there will be an intersection beyond which further growth is uneconomic. The richer the society (the more it has grown in the past), the more likely it is that marginal benefits are below marginal costs and that further growth is uneconomic. That marginal benefits fall follows from the simple fact that sensible people satisfy their most pressing wants first, whether in alternative uses of a single commodity or in alternative uses of income. That marginal costs rise follows from the fact that sensible people first exploit the most accessible land and minerals known to them, and that when sacrifices are imposed by the increase of any one activity, sensible people will sacrifice the least important alternative activities first. Thus marginal benefits of economic activity fall while marginal costs rise. Were this not the case, our previous "economic activity" would not have been economic--less pressing wants would have to have taken priority over more pressing wants, and the level of welfare could have been increased by reallocation with no increase in resources used.

...Once we have gone beyond the optimum, and marginal costs exceed marginal benefits, growth will make us worse off. Will we then cease growing? On the contrary, our experience of diminished well-being will be blamed on the traditional heavy hand of product scarcity, and the only way the orthodox paradigm knows to deal with increased scarcity is to advocate increased growth--this will make us even less well off and will lead to the advocacy of still more growth! Sometimes I suspect that we are already on this "other side of the looking glass," where images are inverted and the faster we run the "behinder" we get.

Environmental degradation is an iatrogenic disease induced by the economic physicians who attempt to treat the basic sickness of unlimited wants by prescribing unlimited production. We do not cure a treatment-induced disease by increasing the treatment dosage! Yet members of the hair-of-the-dog-that-bit-you school, who reason that it is impossible to have too much of a good thing, can hardly cope with such subtleties. If an overdose of medicine is making us sick, we need an emetic, not more of the medicine. Physician, heal thyself

Consistent Inconsistencies and Avoiding the Main Issues Growthmen are forever claiming that neither they nor any other economist worth his salt has ever confused GNP with welfare. Consider, however, the following four statements from the same article (Nordhaus and Tobin, 1970):

(1) Gross National Product is not a measure of economic welfare....maximization of GNP is not a proper objective of economic policy....Economists all know that...[p. 6].

(2) Although GNP and other national Income aggregates are imperfect measures of welfare, the broad picture of secular progress which they convey remains after correction of their most obvious deficiencies [p. 25].

*(3) But for all its shortcomings, national output is about the only broadly based index of economic welfare that has been constructed [p. 1, Appendix A].

*(4) There is no evidence to support the claim that welfare had grown less rapidly than NNP.

Rather NNP seems to underestimate the gain in welfare, chiefly because of the omission of leisure from consumption. Subject to the limitations of the estimates we conclude that the economic welfare of the average American has been growing at a rate which doubles every thirty years [p. 12].

It is asking too much of context and intervening qualification to reconcile statement 1 with statements 2,3, and 4. Either GNP (or NNP) is an index of welfare, or it is not. The authors clearly believe that it is (in spite of the first statement). They offer many sensible adjustments to make GNP a better measure of welfare on the assumption that, although imperfect, it is nevertheless a measure of welfare. But all of this avoids the fundamental objection that GNP-flow is largely a cost. Wants are satisfied by the services of the stock of wealth. The annual production flow is the cost of maintaining the stock, and though necessary, should be minimized for any given stock level. If we want the stock to grow, we must pay the added cost of a greater production flow (more depletion, more labor, and ultimately more pollution). Depletion, labor, and pollution are real costs that vary directly with the GNP-throughput. If we must have some indices of welfare, why not take total stock per capita and the ratio of total stock to throughput flow? Welfare varies directly with the stock, inversely with the flow. Beyond some point, the benefits of additions to the stock will not be worth the costs in terms of additional maintenance throughput.

Kenneth Boulding has for many years been making the point that Gross National Product is largely Gross National Cost and has never been taken seriously. If this way of looking at things is wrong, why does not some economist deal it a decisive refutation instead of avoiding it? Certainly it is not a minor issue.

The source of this flow fetishism of orthodox economics is twofold. First, it is a natural concomitant of early stages of ecological succession (Odum, 1969). Young ecosystems (and cowboy economies) tend to maximize production efficiency, that is, the ratio of annual flow of biomass produced to the preexisting biomass stock that produced it. Mature ecosystems (and spaceman economies) tend to maximize the inverse ratio of existing biomass stock to annual biomass flow that maintains it. The latter ratio increases as maintenance efficiency increases. Economic theory is lagging behind ecological succession. The other reason for flow fetishism is ideological. Concentrating on flows takes attention away from the very unequally distributed stock of wealth that is the real source of economic power. The income flow is unequally distributed also, but at least everyone gets some part of it, and marginal productivity theory makes it appear rather fair. Redistribution of income is liberal. Redistribution of wealth is radical. Politically, it is safer to keep income at the center of analysis, because not everyone owns a piece of the productive stock, and there is no theory explaining wealth distribution. Putting stocks at the center of analysis might raise impolite questions.

Crocodile Tears from Latter-Day Marie Antoinettes

Economists and businessmen with no previous record of concern for the poor have now begun to attack steady-state advocates as upper-class social climbers, who, having gotten theirs, now want to kick the ladder down behind them and leave the poor forever on the ground floor. There may be such people, and certainly they should be condemned. But most advocates of the steady state accept and proclaim the absolute necessity of limits to inequality in the distribution of both wealth and income. Indeed, many people who have long favored less inequality in the distribution of wealth on ethical and political grounds have reached the same conclusion on ecological grounds. It is the orthodox growthmen who want to avoid the distribution issue. As Wallich so bluntly put it in defending growth, "Growth is a substitute for equality of income. So long as there is growth there is hope, and that makes large income differentials tolerable" (1972). We are addicted to growth because we are addicted to large inequalities in income and wealth. What about the poor? Let them eat growth! Better yet, let them feed on the hope of eating growth in the future!

We have been growing for some time, and we still have poverty. It should be obvious that what grows is the reinvested surplus, and the benefits of growth go to the owners of surplus, who are not poor. Some of the growth dividends trickle down, but not many. The poor are given the sop of full employment-they are allowed to share fully in the economy's basic toil but not in its surplus--and unless we have enough growth to satisfy the dividend recipients, even the booby prize of full employment is taken away.

On the issue of growth and poverty, Joan Robinson noted:

Not only subjective poverty is never overcome by growth, but absolute poverty is increased by it. Growth requires technical progress and technical progress alters the composition of the labor force, making more places for educated workers and fewer for uneducated, but opportunities to acquire qualifications are kept (with a few exceptions for exceptional talents) for those families who have them already [Robinson, 1972, p. 7].

Admitting the Thin Edge of a Big Wedge

"We know that population growth cannot continue forever" (Nordhaus and Tobin, 1970, p. 20). This is certainly a true statement. It is also the thin edge of a wedge whose thick end is capable of cracking the growth orthodoxy in half. This results from the fact that, in addition to the population of human bodies (endosomatic capital), we must also consider the population of extensions of the human body (exosomatic capital). Cars and bicycles extend man's legs, buildings and clothes extend his skin, telephones extend his ears and voice, libraries and computers extend his brain, and so on. Both endosomatic and exosomatic capital are necessary for the maintenance and enjoyment of life. Both are physical open systems that maintain themselves in a kind of steady state by continually importing low-entropy matter-energy from the environment and exporting high-entropy matterenergy back to the environment. In other words, both populations require a physical throughput for short-run maintenance and long-run replacements of deaths by births. The two populations depend upon the environment in essentially the same way. The same biophysical constraints that limit the population of organisms apply with equal force to the population of extensions of organisms. If the first limitation is admitted, how can the second be denied?

This simple logic has recently imposed itself on the population of books in college libraries (Gore, 1974). Academic library collections have for several decades been growing at a rate that doubles holdings every fifteen years. Microfilm technology has not substituted for bulkier acquisitions but has led to extra acquisitions. If we admit that every college cannot afford a Library of Congress, and that even that library cannot grow forever, we must accept some kind of a steady-state library. That is, some sufficient number of holdings must be maintained constant, and whenever a new book is added an old one must be discarded. Up to this point there is no escape from the simple logic of the problem.

Difficulties arise in setting the aggregate "birth" and "death" rates and especially in deciding which books are to be acquired and which are to be sacrificed. If to add a new book we must throw away an old one, then the new one must be judged better than the old one. This is surely a healthy discipline and will result in an improvement of quality of the total stock of books. But the problem, as ever, is how to judge quality. A legitimate difference of opinion arises between the consumer sovereignty school (get rid of those books that are checked out least often) and the library responsibility school (rely on the judgment of librarians and scholars). This is a difficult issue and probably requires compromise. But what is certain is that the issue must be faced. No library can continue to buy books indefinitely and never discard any. What is true for books is true for cars, buildings, bicycles, and, of course, for human bodies. At some point, more births must be balanced by more deaths.

Misplaced Concreteness and Technological Salvation

Technology is the rock upon which the growthmen built their church. Since rocks and foundations are concrete entities, it is natural that growthmen should begin to endow technology with a certain metaphorical concreteness, speaking of it as a thing that grows in quantity. From there, it is but a short step to ask whether this thing has grown exponentially, like many other things, and to consult the black art of econometrics and discover that indeed it has! Next, we can conceive of technology as a sort of antibody to the pollution and depletion germs. Ultimately, we conclude that depleting and polluting activities (production and consumption) can continue to grow exponentially, because we have a problem-solving antiparticle, technology which can also grow exponentially!

Is this progression an unfair caricature? Consider the following statement from a review of Limits to Growth (Meadows et al., 1972) by two economists and a lawyer:

While the team's world model hypothesizes exponential growth for industrial and agricultural needs, it places arbitrary, nonexponetial, limits on the technical progress that might accommodate these needs.

...It is true that exponential growth cannot go on forever if technology does not keep up--and if that is the case we might save ourselves much misery by stopping before we reach the limits. But there is no particular criterion beyond myopia on which to base that speculation. Malthus was wrong; food capacity has kept up with population. While no one knows for certain, technical progress shows no signs of slowing down. The best econometric estimates suggest that it is indeed growing exponentially [Passell et al., 1972, p. 12].

These few sentences are very valuable in that they unite in one short space so many of the misconceptions of orthodox growthmen. Note that technology has become an exponentially growing quantity of some thing that solves problems but does not create any. Note the clear implication that exponential growth could go on forever if technology (that problem-

solving antiparticle) can keep up. Can it in fact keep up? Consult the entrails of a nameless econometrician and, behold! It has in the past, so it probably will in the future. Most econometricians are more cautious in view of the fact that technological change cannot be directly measured but is merely the unexplained residual in their regressions after they have included as many measurable factors and dummy variables as they can think of Sometimes the residual technology component even includes the effect of increased raw material inputs! Note also the blind assertion that Malthus was wrong, when in fact his predictions have been painfully verified by the majority of mankind. But then majorities have never counted. Only the articulate, technically competent minority counts. But even for them Malthus was not really wrong, since this minority has heeded his advice and limited its reproduction.

The idea that technology accounts for half or more of the observed increase in output in recent times is a finding about which econometricians themselves disagree. For example, D. W. Jorgenson and Z. Grilliches found that "if real product and real factor input are accurately accounted for, the observed growth in total factor productivity is negligible" (1967). In other words, the increment in real output from 1945 to 1965 is almost totally explained (96.7 percent) by increments in real inputs, with very little residual (3.3 percent) left to impute to technical change. After taking account of critical reviews of their study, Jorgenson and Grilliches admitted the likelihood that a greater role was played by technological change but reaffirmed their basic conclusion "that total factor input, not productivity change, predominates in the explanation of the growth of output" (Jorgenson and Grilliches, 1972, p. 111). G. S. Maddala found that for the bituminous coal industry "growth in labor productivity can be explained almost totally by a rise in the horsepower per worker. Thus what formerly was considered as technical change now appears as a process of factor substitution" (1965, p. 352). Such findings cast doubt on the notion that technology, unaided by increased resource flows, can give us enormous increases in output. In fact, the law of conservation of matter and energy by itself should make us skeptical of the claim that real output can increase continuously with no increase in real inputs.

Norman Royall, a far more perceptive reviewer of The Limits to Growth, has noted a similar confusion and lucidly comments on it:

Some critics of "Limits" berate the authors for not including exponentially growing technical knowledge as a sixth constituent of the World Model. Such criticism elaborately misses the point. The other constituents have real, physical referents that can be quantified: population can be counted, barrels of petroleum consumed can be enumerated and part per million of abrasive chemicals in the smog of Los Angeles can be measured.

Sheer "knowledge" means nothing for the world system until it enters one of the other five constituents, and the tacit assumption that all technical knowledge necessarily enters as a good is unwarranted. Is the technical knowledge that performance of gasoline engines can be improved by adding tetraethyl lead to their fuel a "good"? [Royal!, 1972, p. 421.

In other words, the projections of physical growth trends already include the effects of past technical "progress" as these effects were registered in the five physical referents of the model. The tacit assumption is that the influence of technology on the physical world will, in the future, change in ways similar to the way it has changed in the past.

We need not accept The Limits to Growth in its entirety; it is clear, however, that whether or not technology has grown exponentially is largely irrelevant. The assumption of some critics that technological change is exclusively a part of the solution and no part of the problem is ridiculous on the face of it and totally demolished by the work of Barry Commoner (1971). We need not accept Commoner's extreme emphasis on the importance of the problem-causing nature of post-World War II technology (with the consequent downplaying of the roles of population and affluence) in order to recognize that recent technological change has been more a part of the problem than of the solution. The key questions are: What kind of technology is part of the solution? What type of institutional sieve will let pass the good kind of technology while blocking the bad kind? This issue was dealt with in the discussion in Chapter 3 of the depletion quota auction, which provides such a sieve in the form of higher resource prices.

But Resources Are Such a Small Percentage of GNP

Perhaps another "justification" for ignoring resources is the small value component of GNP they represent. In 1968 minerals production represented 1.7 percent of GNP and total fossil fuels, 2.0 percent (Goeller, 1972, p. 15).* Why is it that our price system imputes such a small share of total value produced to resources and such a large share (the remainder) to labor and capital? Does this vindicate the assumption that resources are ultimately not scarce? Or does it simply mean that they are underpriced? I believe the latter is the case** and that this underpricing results from the relative power of social classes that conditions the functioning of the market. Specifically, labor and capital are two powerful

social classes, while resource owners, for good reasons, are not. Let us see how this rigs the market in favor of low resource prices.

[*The optimistic" conclusion of Goeller's paper is that "assuming reasonable management the resource base of the earth is sufficient to maintain the present state of material affluence of the United States, and to share it to some meaningful degree with the rest of the world, for at least the next hundred years" (p. 1: my Italics). In other words, If we move rapidly and efficiently to a steady state at present levels, and draw on all the world's resources, and limit our sharing with the rest of the world to some "meaningful degree," our system could continue for the next hundred years Such optimism makes pessimism redundant.

**It would be interesting, following Ise's suggestion noted in Chapter 3, to calculate the value of nonrenewable resources priced at the price of their nearest renewable substitute--for example, petroleum priced at the Btu equivalent of, say, wood alcohol. No doubt the picture would be very different.]

In the short run, we have a given technology and given amounts of the fund factors, labor and capital. It takes time to change the capital stock and to change the size of the working-age population. Suppose we desire to increase the incomes of both capital and labor in the short run. Since the incomes of capital and labor are tied to their respective productivities, it becomes necessary to increase these productivities. Under short-run assumptions, the only way to increase the productivities of both fund factors is to increase the flow factors of raw materials and power. As the flow of resource throughput is increased with a given fund of labor and capital, the productivity of the resource flow must, by the law of diminishing returns, decrease. All three productivities cannot increase in the short run. It is clear that the flow factor's productivity is the one that is going to be sacrificed, since in the short run it is the only one whose quantity can be increased. Furthermore, even in the longer run, with all factors variable but no technological change, it is clear that resource productivity will also lose out. The tie between labor productivity and labor income, plus the monopoly power of labor unions, will keep labor productivity from being sacrificed. The tie between capital productivity and profit, along with the monopoly power of large corporations, will keep capital productivity from being sacrificed.

Capital and labor are the two social classes that produce and divide up the firm's product. They are in basic conflict but must live together. They minimize conflict by growth and by throwing the growth-induced burden of diminishing returns onto resource productivity. How do they get away with it? In earlier times it might not have worked; a strong landlord class would have had an interest in keeping resource prices from falling too low. But today we have no such class to exert countervailing upward pressure on resource prices. Although resource owners do exist and they do prefer higher to lower prices, other things being equal, it remains true that no social class is as effective in promoting resource productivity as the capitalists and laborers are in promoting the productivities of their respective factors.

Suppose we allow for technological change in the long run. Now it is possible for all three productivities to increase. But how likely is it? Given the desire to increase incomes of labor and capital, innovations that increase these two productivities will have first priority, while those that increase mainly resource productivity will not be stimulated. Given low prices for resources, it will not matter much to entrepreneurs what happens to resource productivity. And surely it is easier to invent a new technology that increases the productivity of two factors than to invent one that increases all three productivities.

Should we, by a kind of reverse land reform, reinstate a landlord class? Landlord rent is unearned income, and we find income based on ownership of that which no one produced to be ethically distasteful. No one loves a landlord. Adam Smith tells us that landlords love to reap where they have never sown, and not many lament the historical demise of the landowning aristocracy. But not all the long-run consequences of this demise are favorable. Rent may be an illegitimate source of income, but it is a totally legitimate and necessary price, without which efficient allocation of scarce resources would be impossible. Henry George said let rent be charged but then tax it away. Socialists, after trying to get along without rent, now say charge some rent but pay it to the government, who is now the landlord. In the United States neither of these things has happened. The largest resource owner, the government, has followed a give-away and low price policy, both on resources it owns and on those, such as natural gas, whose price it regulates (Energy Policy Project, 1974, Chapter 11). It has done this to favor certain capitalists, to promote growth, and to ease the labor-capital conflict and win votes in both camps.

Moreover, imports of resources from underdeveloped countries, which have not yet learned how to use them, have naturally been cheap because of the low short-run opportunity cost to the exporting country. This pattern is now changing, but in the past it has been a factor in keeping resource prices low. Some resources are owned by capitalists, who are likely to be much more interested in maximizing growth and minimizing conflict through low resources prices than in making

profits on sales of resources. In fact, the capitalist's ownership of resources will generally be for the purpose of lowering the cost price of those resources to himself as capitalist, by means of vertical integration, in order to increase the returns to capital. Capital is the dynamic, controlling factor. It is not for nothing that our economic system is called "capitalism" rather than "resourceism."

Present Value and Positive Feedback

It is sometimes argued that the market automatically provides for conservation by offering high profits to farsighted speculators who buy up materials and resell them later at a higher price. There are at least two things wrong with this argument.

First, exponentially growing extraction leads to "unexpectedly" sudden exhaustion. Suppose the doubling time of the cumulative total amount extracted is on the order of 30 years, as it apparently is for many resources, and that there is enough of the resource to last for 300 years at present growth rates. At the end of 270 years the resource would only be half depleted. Yet in the final 30 years it would go from half to total depletion. Most resource owners probably find that surprising. For linear trends, the past is a good guide to the future. For exponential growth, the past is a deceptive guide to the future.

The second problem is that the future profit must be discounted to its present value. The investor has the alternative in an expanding economy of depleting now and investing the short-term profits in another line that will earn the expected going rate, which will be close to the growth rate of the economy. The discount rate he applies to future profit is the same as the rate at which he would expect his reinvested short-term profits to grow. This expected rate is determined largely by the current rate and by recent changes in the current rate. The result is that high and increasing current growth rates, based on high and increasing current depletion rates, lead to high and increasing discount rates applied to future values. The last condition in turn leads to a low incentive to conserve, which feeds back to high current depletion and growth rates, high discount rates, and so forth. Present value calculations thus have an element of positive feedback that is destabilizing from the point of view of conservation. Financial prudence usually advises depleting now and investing short-term earnings in depleting some other resource. The presumption again is infinite resources. There will always be more material and energy resources available to feed the march of compound interest, with its consequent discounting of future values and disincentive to conservation. This tacit assumption sometimes becomes explicit, as in the following statement from the president of a great oil company:

The fact seems to be that the first [resource] storehouse in which man found himself was only one of a series. As he used up what was piled in that first room, he found he could fashion a key to open a door into a much larger room. And as he used up the contents of this larger room, he discovered there was another room beyond, larger still. The room in which we stand at the middle of the twentieth century is so vast that its walls are beyond sight. Yet it is probably still quite near the beginning of the whole series of storehouses. It is not inconceivable that the entire globe--earth, ocean and air--represents raw material for mankind to utilize with more and more ingenuity and skill [quoted in Ordway, 1953, p. 281.

Such is the assumption of orthodox growth economics. Even if this vision were correct, we should add that eventually we must live in the same rooms we work in. Living in intimate contact with garbage and noxious wastes is a by-product of growth. But optimists will argue that there is another infinite series of ever larger garbage dumps! The whole conceptual basis of the growth faith is equivalent to a generalization of the chain-letter swindle. There will always be five new resources for every depleted resource. The current beneficiaries of the swindle, those at the beginning of the chain, try hard to keep up the illusion among those doubters at the end who are beginning to wonder if there are really sufficient resources in the world for the game to continue very much longer.

Youth Culture and Frustrated Pyramid Climbers

A stationary population is a part of a steady-state economy. Assuming present mortality rates, the attainment of a stationary population would imply an increase in the average age of the population from the current twenty-seven to about thirty-seven years. This raises fears of social senility, excessive conservatism, loss of adaptability and dynamism, and so forth. This hardly seems a reasonable fear, even for devotees of the "Pepsi generation." We need only compare Sweden, with one of the oldest age structures, to Brazil, with one of the youngest. It would certainly be stretching things a bit to say that old Sweden is a reactionary, non innovative gerontocracy, while young Brazil is a progressive, innovative country run by young people. We might just as well argue that Brazil values youth less than Sweden because its infant mortality rates are higher, and therefore Sweden is more youth-oriented than Brazil. Such arguments are simplistic at best.

The stationary population "pyramid" would be shaped more like a house (rectangular up to about age fifty, where the roof begins and rapidly tapers to a peak). But the structure of authority in hierarchical organizations remains a pyramid. Thus there would, in the future, be less of a congruence between advancing age and advancing position. More people would grow older at lower levels of authority, and many ambitions would be frustrated. The observation is a highly interesting one and no doubt has important sociological implications. But they are not all negative by any means. More individuals will learn to seek personal fulfillment outside hierarchical organizations. Within such organizations, fewer people will be automatically promoted to their level of incompetence, thus thwarting the so-far relentless working of the "Peter Principle." Perhaps giant bureaucracies will even begin to dissolve and life will reorganize on a more human scale.

Pascal's Wager Revisited

The growthmania position rests on the hypothesis that technological change can become entirely problem solving and not at all problem creating and can continually perform successively more impressive encores as resources are depleted. There is sufficient evidence to make reasonable people quite doubtful about this hypothesis. Yet it cannot be definitely disproved. There is a certain amount of faith involved, and faith is risky. Let us then take a completely agnostic position and apply the logic of Pascal's wager and statistical decision theory. We can err in two ways: we can accept the omnipotent technology hypothesis and then discover that it is false, or we can reject it and later discover that it is true. Which error do we most wish to avoid? If we accept the false hypothesis, the result will be catastrophic. If we reject the true hypothesis, we will forgo marginal satisfactions and will have to learn to share, which, though difficult, might well be good for us. If we later discover that the hypothesis is true we could always resume growth. Thus even in the agnostic case, it would seem prudent to reject the omnipotent technology hypothesis, along with its corollary that reproducible capital is a near-perfect substitute for resources.

The Fallacy of Exponentially Increasing Natural Resource Productivity

In a previous section we considered the orthodox position that the productivity of reproducible capital increases exponentially, thanks to exponential technological progress. The problem noted was that exponential technological progress, as measured in two-factor production functions is usually accompanied by exponential increases in resource throughput (depletion and pollution), which remain outside the analysis. It is of little comfort to contemplate increasing productivity of labor and capital if it is at the continuing expense of resource productivity and if resources are the ultimately scarce factor. Robert Solow has defended growth by directly appealing to increasing resource productivity. Solow concludes that "there is really no reason why we should not think of the productivity of natural resources as increasing more or less exponentially over time" (1973, p. 51). This remarkable conclusion, if true, would be a boon to those who advocate limiting the throughput of resources, because it would mean that such a limit is totally consistent with continued exponential growth in GNP and is therefore not such a radical proposal. The resource flow could be stabilized and GNP could continue to grow exponentially as a resource productivity (i.e., GNP/resource flow) increased exponentially. Why, then, does limiting the resource flow provoke such strong opposition from growth economists?

The arguments Solow presents to support his conclusion are highly interesting. If the productivity of labor is measured by GNP/labor, he reasons, the productivity of iron is measured by GNP/iron output, that of aluminum by GNP/aluminum output, and so on. He calculates what has happened to the productivities of a number of particular resources between 1950 and 1970 and finds that some (iron, manganese, copper, lead, zinc, bituminous coal) have increased, while the productivities of others (nickel, petroleum) have remained the same and those of still others (aluminum, natural gas, electric power, columbium) have fallen. On the face of it, the evidence supports no generalization about resource productivity at all, even accepting Solow's definitions. But even more damaging is a hard look at the facile analogy between labor productivity and coal productivity, columbium productivity, and so forth, insofar as particular resource productivities are supposed to add up to, or convey some notion of, aggregate resource productivity, which is what Solow's conclusion clearly required that it should do.

First of all, if the amount of labor used goes up, ceteris paribus, the productivity of labor goes down. If the quantity of all resources used goes up, then ceteris paribus, the productivity of aggregate resources likewise goes down. But the productivity of a good many particular resources will still increase if the GNP happened to increase faster than the quantity of that resource used. Furthermore, the increase in GNP is in part made possible by the more rapid increase in quantity used of those particular resources whose productivities consequently fell over the given period. Solow recognizes this effect: "One of the reasons the productivity of copper rises is because that of aluminum falls, as aluminum replaces copper in many uses" (p. 51). This observation by itself could have restrained Solow from drawing his conclusion.

The meaning of these "resource productivities" is further obscured: "Sooner or later, the productivity of oil will rise out of sight, because the production and consumption of oil will eventually dwindle toward zero, but real GNP will not" (p. 51). Presumably, when production and consumption of oil approach zero, oil productivity will become infinite! The conclusion to be drawn is certainly not that increasing productivity compensates for diminishing supply of resources--otherwise we would be better off with nearly zero output of petroleum, which is absurd. Rather, the warranted conclusion is that Solow is playing around with meaningless numbers that support no conclusions at all.

In his Richard T. Ely Lecture to the American Economic Association, Solow went as far as to proclaim not only the conditional possibility, but the empirical likelihood that "the world can, in effect, get along without natural resources" (1974, p. 11). Solow elaborates that this is so if we have a "backstop technology," such as breeder reactors, which will mean that "at some finite cost, production can be freed of dependence on exhaustible resources altogether" (1974, p. 11). Apparently, the world cannot get along without all natural resources as he first suggested, but only without exhaustible ones. Just how to build and maintain a backstop technology of breeder reactors (the only example offered) without exhaustible resources such as copper, zirconium, tungsten, and iron, not to mention initial stocks of enriched uranium or permanent depositories for radioactive wastes, is not explained by Solow. No doubt it is true that at "some finite cost" we could live on renewable resources, as mankind essentially did before the industrial revolution. But the finite cost is going to include a reduction in population and in per-capita consumption levels or, at the very least, a cessation of further growth. This is accepted by the steady state view but not by Solow and other victims of the infinite substitutability fallacy, who are forced to lower the deus ex machina of backstop technologies onto the stage in order to save the awkward plot of growthmania. Even a perfect backstop technology, one that would deliver energy "too cheap to bear the cost of metering," to recall the early promises of fission advocates, cannot save the ever growing economy. In fact, "free energy would simply enable the growth-maniacs to destroy the biosphere more quickly. Within the context of a SSE [Steady State Economy]. free energy would be a blessing, but in the present growth context it would be a curse.

The explicit belief in the unlimited productivity of natural resources and the unlimited substitutability of other factors for natural resources has led economist Nicholas Georgescu-Roegen to the following verdict on Solow and the many other economists for whom he is the distinguished spokesman:

One must have a very erroneous view of the economic process as a whole not to see that there are no material factors other than natural resources. To maintain further that "the world can, in effect, get along without natural resources" is to ignore the difference between the actual world and the Garden of Eden [Georgescu-Roegen, 1975, p. 361].

The Ever Expanding Service Sector and "Angelized GNP"

Advocates of growth frequently appeal to the increasing importance of services, which, it is assumed, can continue to grow indefinitely, since such activities are presumable nonpolluting and nondepleting. Thus while agriculture and industry will be limited by their necessary pollution and depletion flows, services are allegedly not so limited and will continue to grow. Therefore, an ever larger fraction of total GNP will originate in the service sector, and consequently the pollution and depletion flows per average dollar of GNP will fall continuously. Presumably, we will approach a nonphysical "angelized GNP."

There are two fatal flaws in this picture. While it is true that some activities are more throughput-intensive than others, it is not clear that these activities are always services, nor is it clear that the differences are very great once indirect effects are incorporated. Eric Hirst found that "services associated with food used almost as much energy as did farming and processing" (1974, p. 135). It is likely that when we add all the indirect as well as the direct aspects of service activities (inputs to service sector, inputs to inputs of service sector, etc.), we will find that services do not pollute or deplete significantly less than many industrial activities. That most services require a substantial physical base is evident from casual observation of a university, a hospital, an insurance company, a barber shop, or even a symphony orchestra. Certainly the incomes earned by people in service sector will not all be spent on services but will in fact be spent on the average consumer basket of both goods and services.

The second flaw in this view is that there are limits to how high the proportion of services to goods can rise in the product mix without provoking a shift in the terms of trade in favor of goods and against services to such an extent that goods production would again expand and service production contract. Historically, employment in the service sector has grown relative to total employment, because productivity and total output of industry and agriculture have increased vastly. Once total output of physical goods is restricted, service sector growth will be increasingly restrained by a progressive deterioration in its terms of trade vis-a-vis physical goods.

It is true that "In 1969 a dollar's worth of GNP was produced with one-half the materials used to produce a dollar's worth of 1900 GNP, in constant dollars" (National Commission on Materials Policy, 1973,p. 3-3). Nevertheless, over the same period total materials consumption increased by 400 percent. We must resist being carried away by the halving of the material content of a GNP dollar. Remember the man who bought a new stove that cut his fuel bill in half and then reasoned that he could cut his fuel bill to zero by buying another such stove! More significant than the halving of the materials per dollar of GNP is the quintupling of the absolute material throughput and the similar increase in energy throughput over the same time period.

The idea of economic growth overcoming physical limits by angelizing GNP is equivalent to overcoming physical limits to population growth by reducing the through put intensity or metabolism of human beings. First pygmies, then Tom Thumbs, then big molecules, then pure spirits. Indeed, it would be necessary for us to become angels in order to subsist on angelized GNP.

Misleading Views on Misallocation and Growth

Many growth economists (Beckerman, 1974, p. 20) have argued that in order to prove that the growth rate is excessive it is necessary to show that the resource misallocation at any point of time takes the form of excessive investment. This reflects a commonly held position among economists that the market will automatically limit growth at some optimal rate. But we must first ask just what "misallocation," or more specifically "excess investment," means in the context of the statement. It means that more is being invested and less consumed out of current production than would be the case under freely competitive markets and consumer sovereignty. Misallocation is defined with respect to the competitive market equilibrium of the plans of savers with the plans of investors, not with respect to physical relations of the economy with the ecosystem. Excessive "disinvestment" of geological capital (depletion), excessive pollution and destruction of ecosystems, and excessively onerous technologies are all consistent with the condition that savers in the aggregate are planning to see just what investors in the aggregate are planning to invest. The market seeks its behavioral equilibrium without regard for any ecological limits that are necessary to preserve bio1 physical equilibrium. There is no reason to expect that a short-run behavioral equilibrium will coincide with a long-run (or even a short-run) biophysical equilibrium. In fact, it is clear that under present institutions the two will not coincide. The behavioral equilibrium between planned saving and planned investment nearly always occurs at positive levels of net saving and investment. Positive net investment means growth, which means an increasing throughput and increasing biophysical disequilibrium.

Orthodox growth economists are likely to reply that if only we could internalize all true ecological costs into money prices, then market equilibrium would coincide with ecological equilibrium. This is a bit like Archimedes saying that if only he had a fulcrum and a long enough lever he could move the world. Even granting the impossible task of internalization, all that means is that ala relative scarcities are properly evaluated. Growth could continue and absolute scarcity could become ever greater, even though relative prices were at all times perfect measures of relative scarcity. Correct relative prices can help us bear the burden of absolute scarcity in the least uncomfortable way but cannot stop the weight of the burden itself from increasing.

Excessive growth is sometimes thought of by economists as a misallocation over time--the present is sacrificing too much current consumption to capital accumulation for the future. Conservationists looking at the same rapid growth attribute it to too little concern for the future, evidenced by rapid depletion of resources. Who is right? It depends on which is the limitative factor, capital stocks or resource flows. If resources are superabundant and capital scarce, the economist is right. As we have repeatedly seen, many economists effectively assume infinite resources. If resources are scarce, then the conservationist is right. The future inherits not only a positive bequest of more capital but also a negative bequest of depleted mines and polluted sinks. And refineries and super tankers are not very productive capital if there is not much petroleum left.

The intergenerational costs of growth are not at all clear, but as time goes on it would seem that the negative bequest of accelerated entropy increase would weigh increasingly heavily since low entropy is the ultimate means upon which all technologies depend. The market is not able to allocate goods temporally over more than one generation. Indeed, when different generations (different people) are involved, the issue is one of distribution not allocation. Future people cannot bid in present markets. Current markets cannot reflect the needs of future people, except as they are represented by concerned people in the present, whose concern rarely exceeds one or two generations. As Georgescu-Roegen (1975) points out, markets are temporally parochial, and consequently market prices cannot reflect the long-run value of resources any more than the market prices at an art auction held in Wink, Texas would determine the true value of the Mona Lisa. If prices are to measure values, all interested parties must be allowed to bid. For the future this is impossible.

There is no objective market criterion for determining proper intergenerational allocation nor, consequently, for speaking of misallocation. In any case the proper word is "misdistribution."

Moreover, even within the present many natural values cannot be priced in markets at all. Consider the instructive case in which a juke box in a student cafeteria disturbed some students who preferred silence. They petitioned for the removal of the offending machine. The music lovers replied that the juke box was a democratic machine, like a free market, and if the disgruntled did not like what they heard they could vote with their money to hear something else. The objection, of course, was that the silence-lovers' money could not buy silence. The clever solution was to include a three-minute silent disc among the choices. This solution is notable for its uniqueness; in most cases, silence, clean air and water, and so forth cannot be purchased in discrete units by individuals, and their values cannot be defended against their opposites in competitive markets. They must be protected by physical boundaries that restrict the domain of the market without crippling the functioning of the market within its limited domain. This is the mode of operation of the three institutions proposed in Chapter 3.

The direct reply to the initial assertion then is: No, it is not necessary to show that excessive investment exists in order argue that the growth rate is excessive. There are other criteria more basic than those of a competitive behavioral equilibrium for defining excessive growth. These are biophysical criteria that cannot be internalized in market prices. Market equilibrium under present institutions usually implies biophysical disequilibrium. Nor can the market handle intergenerational distribution. All interdependencies over time and space cannot be fit to the procrustean bed of an unrestricted price system.

What Second Law?

It was argued in Chapter 2 that growth economists were confused about ultimate means, or low-entropy matter-energy. It might be useful here to document a few examples of economists' disregard for the second law of thermodynamics.

In an article defending growth, Harvard economist Richard Zeckhauser tells us that "Recycling is not the solution for oil, because the alternate technology of nuclear power generation is cheaper" (1973, p. 117, n. 11). The clear meaning of the sentence is that recycling oil as an energy source is possible but just happens to be uneconomical, because nuclear energy is cheaper. The real reason that energy from oil, or any other source, is not recycled is of course the entropy law, not the relative price of nuclear power. This nonsensical statement is not just a minor slip-up that we can correct and forget; it indicates a fundamental lack of appreciation of the physical facts of life. No wonder Zeckhauser is unconvinced by limits to growth arguments; if he is unaware of the entropy law he could not possibly feel the weight of the arguments against which he is reacting in his article.

An article entitled "The Environment in Economics: A Survey" Begins with the words: "Man has probably always worried about his environment because he was once totally dependent on it" (Fisher and Peterson, 1976, p. 1). The implication is that man is no longer totally dependent on his environment, or at least that he has become less dependent. Presumably, technology has made man increasingly independent of his environment. But, in fact, technology has merely substituted nonrenewable resources for renewables, which is more an increase than a decrease in dependence. How could man possibly become more independent of his environment without shutting off exchanges with the environment or reducing depletion and pollution, rather than increasing them? For man to exist as a closed system, engaging in no exchanges with the environment, would require suspension of the second law. Man is an open system. What was man three months ago is now environment; what was environment yesterday is man today. Man and environment are so totally interdependent it is hard to say where one begins and the other ends. This total interdependence has not diminished and will not in the future, regardless of technology.

The statement, already cited, by Barnett and Morse that "Nature imposes particular scarcities, not an inescapable general scarcity," is about as clear a denial of the second law as could be imagined. To drive the point home they add:

Science by making the resource base more homogeneous, erases the restrictions once thought to reside in the lack of homogeneity. In a neo-Ricardian world, it seems, the particular resources with which one starts increasingly become a matter of indifference....Advances in fundamental science have made it possible to take advantage of the uniformity of energy/matter--a uniformity that makes it feasible without preassignable limit to escape the quantitative constraints imposed by the character of the earth's crust [Barrett and Morse, 1973, p. 11].

It is, however, not the uniformity of matter-energy that makes for usefulness, but precisely the opposite. It is

nonuniformity, differences in concentration and temperature, that makes for usefulness. If all materials and energy were uniformly distributed in thermodynamic equilibrium, the resulting "homogeneous resource base" would be no resource at all. There would be a complete absence of potential for any process, including life! The economist's notion of infinite substitutability bears some resemblance to the old alchemists' dream of converting base metals into precious metals. All you have to do is rearrange atoms! But the potential for rearranging atoms is itself scarce, so the mere fact that everything is made up of the same homogeneous building blocks does not abolish scarcity. Only Maxwell's Sorting Demon could turn a pile of atoms into a resource, and the entropy law tells us that Maxwell's Demon does not exist.

Zero Growth and the Great Depression

One of the more disingenuous arguments against the SSE [Steady State Economy] was put forward by the editors of Fortune, who stated that "the country has just gone through a real life tryout of zero growth" (1976, p. 116). This was the period 19731975, a period remembered "not as an episode of zero growth but as the worst recession since the 1930s."

Fortune identifies a SSE with a failed growth economy. A condition of nongrowth can come about in two ways: as the failure of a growth economy, or as the success of a steady-state economy. The two cases are as different as night and day. No one denies that the failure of a growth economy to grow brings unemployment and suffering. It is precisely to avoid the suffering of a failed growth economy (we know growth cannot continue) that we advocate a SSE. The fact that an airplane falls to the ground if it tries to remain stationary in the air simply reflects the fact that airplanes are designed for forward motion. It certainly does not imply that a helicopter cannot remain stationary. A growth economy and a SSE are as different as an airplane and a helicopter. Growthmania reigns supreme when even the failures of a growth economy become arguments in its defense!

Conclusions from the Growth Debate

To a large degree, the growth debate involves a paradigm shift of a gestalt switch--a change in the preanalytic vision we bring to the problem. Conversion cannot be logically forced by airtight analytical demonstrations by either side, although dialectical arguments can sharpen the basic issues. But as the growing weight of anomaly complicates thinking within the growth paradigm to an intolerable degree, the steady state view will become more and more appealing in its basic simplicity. In any case, orthodox economics will not easily recover from the weaknesses that some of its leading practitioners have revealed in their efforts at self-defense. It is, to say the least, doubtful that "the world can, in effect get along without natural resources." But it is certain that the world could do very well indeed without "the orthodox economists whose common sense has been insufficient to check their faulty logic."

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