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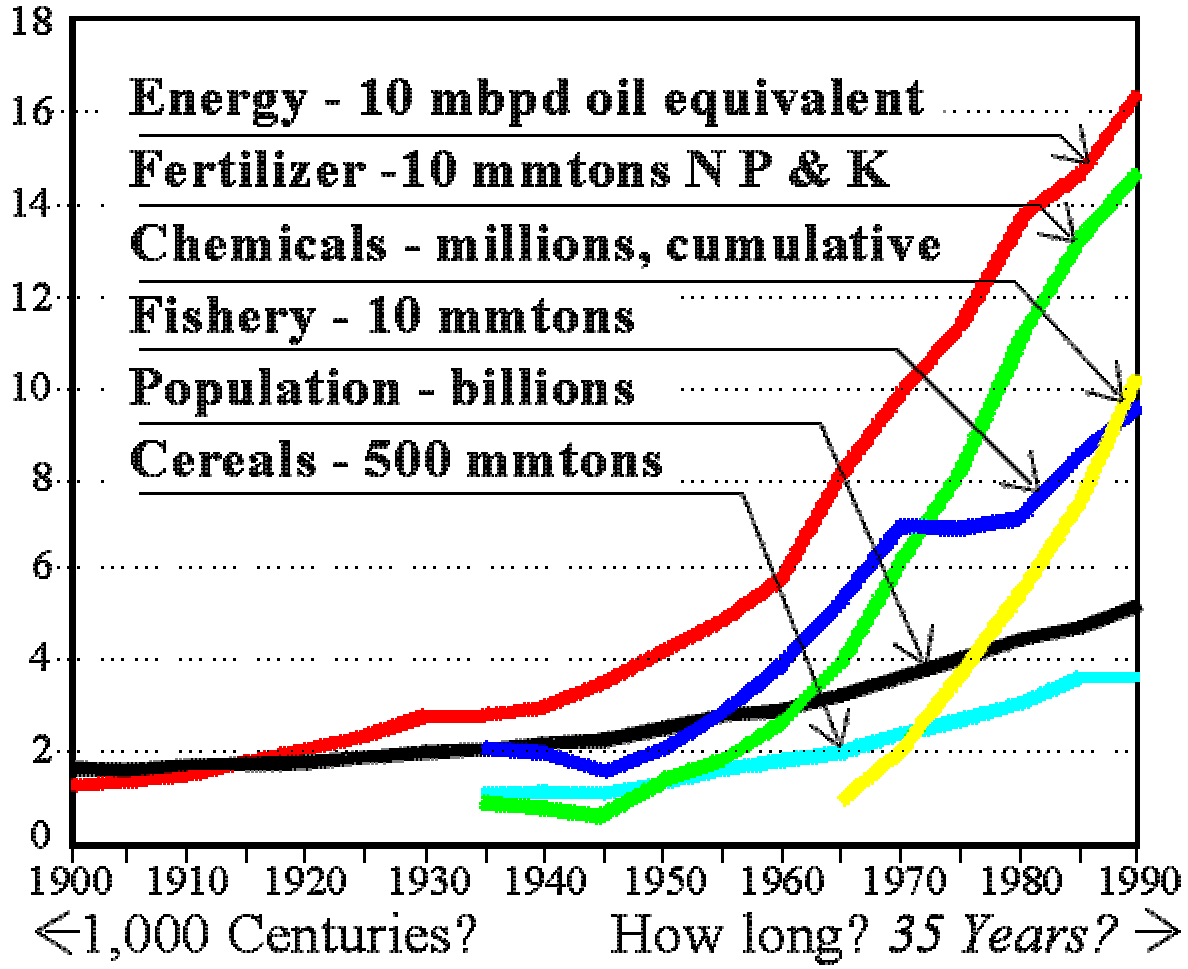


HOW MANY AMERICANS?, Bouvier and Grant;
Sierra Club Books, 1994; ISBN 0-87156-496-3

THE BASIC PESSIMIST MODEL

by Tom Tietenberg

Harper Collins, 1992; ISBN 0-673-46328-1
ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS (third edition)

One end of the spectrum is defined by an ambitious study published in 1972 under the title *The Limits to Growth.* Based on a technique known as *systems dynamics,* developed by Professor Jay Forrester at MIT, a large-scale computer model was constructed to simulate likely future outcomes of the world economy. The most prominent feature of systems dynamics is the use of feedback loops to explain behavior. The *feedback loop* is a closed path that connects an action to its effect on the surrounding conditions which, in turn, can influence further action. As the examples presented subsequently in this chapter demonstrate, depending on how the relationships are described, a wide variety of complex behavior can be described by this technique.

Conclusions of Pessimist Model

Three main conclusions were reached by this study. The first suggests that within a time span of less than 100 years with no major change in the physical, economic, or social relationships that have traditionally governed world development, society will run out of the nonrenewable resources on which the industrial base depends. When the resources have been depleted, a precipitous collapse of the economic system will result, manifested in massive unemployment, decreased food production, and a decline in population as the death rate soars. There is no smooth transition, no gradual slowing down of activity; rather, the economic system consumes successively larger amounts of the depletable resources until they are gone. The characteristic behavior of the system is overshoot and collapse (see Figure 1.1).

The second conclusion of the study is that piecemeal approaches to solving the individual problems will not be successful. To demonstrate this point, the authors arbitrarily double their estimates of the resource base and allow the model to trace out an alternative vision based on this new higher level of resources. In this alternative vision the collapse still occurs, but this time it is caused by excessive pollution generated by the increased pace of industrialization permitted by the greater availability of resources. The authors then suggest that if the depletable resource and pollution problems were somehow jointly solved, population would grow unabated and the availability of food would become the binding constraint. In this model the removal of one limit merely causes the system to bump subsequently into another one, usually with more dire consequences.

As its third and final conclusion, the study suggests that overshoot and collapse can be avoided only by an immediate limit on population and pollution, as well as a cessation of economic growth. The portrait painted shows only two possible outcomes: the termination of growth by self-restraint and conscious policy—an approach that avoids the collapse—or the termination of growth by a collision with the natural limits, resulting in societal collapse. Thus, according to this study, one way or the other, growth will cease. The only issue is whether the conditions under which it will cease will be congenial or hostile.

The Nature of the Model

Why were these conclusions reached? Clearly they depend on the structure of the model. By identifying the characteristics that yield these conclusions, we can examine the realism of those characteristics.

The dominant characteristic of the model is exponential growth coupled with fixed limits. Exponential growth in any variable (for example, 3% per year) implies that the absolute increases in that variable will be greater and greater each year. Furthermore, the higher the rate of growth in resource consumption, the faster a fixed stock of it will be exhausted. Suppose, for example, current reserves of a resource are 100 times current use and the supply of reserves cannot be expanded. If consumption were not growing, this stock would last 100 years. However, if consumption were to grow at 2% per year, the reserves would be exhausted in 55 years; and at 10%, exhaustion would occur after only 24 years.

Several resources are held in fixed supply by the model. These include the amount of available land and the stock of depletable resources. In addition, the supply of food is fixed relative to the supply of land. The combination of exponential growth in demand, coupled with fixed sources of supply, necessarily implies that, at some point, resource supplies must be exhausted. The extent to which those resources are essential thus creates the conditions for collapse.

This basic structure of the model is in some ways reinforced and in some ways tempered by the presence of numerous positive and negative feedback loops. **Positive feedback** loops are those in which secondary effects tend to reinforce the basic trend. An example of a positive feedback loop is the process of capital accumulation. New investment generates greater output, which, when sold, generates profits. These profits can be used to fund additional new investments. This example suggests a manner in which the growth process is self-reinforcing.

Positive feedback loops may also be involved in global warming. Scientists believe, for example, that the relationship between emissions of methane and global warming may be described as a positive feedback loop. Since methane is a greenhouse gas, increases in methane emissions contribute to global warming. As the planetary temperature rises, however, it could release extremely large quantities of additional methane, and so on.

Human responses can intensify environmental problems. When shortages of a commodity are imminent, for example, consumers typically begin to hoard the commodity. Hoarding intensifies the shortage. Similarly, people faced with shortages of food commonly eat the seed that is the key to more plentiful food in the future. Situations giving rise to this kind of downward spiral are particularly troublesome.

A *negative feedback loop* is self-limiting rather than self-reinforcing, as illustrated by the role of death rates in limiting population growth in the model. As growth occurs, it causes larger increases in industrial output, which, in turn, cause more pollution. The increase in pollution triggers a rise in death rates, retarding population growth. From this example it can be seen that negative feedback loops can provide a tempering influence on the growth process, though not necessarily a desirable one.

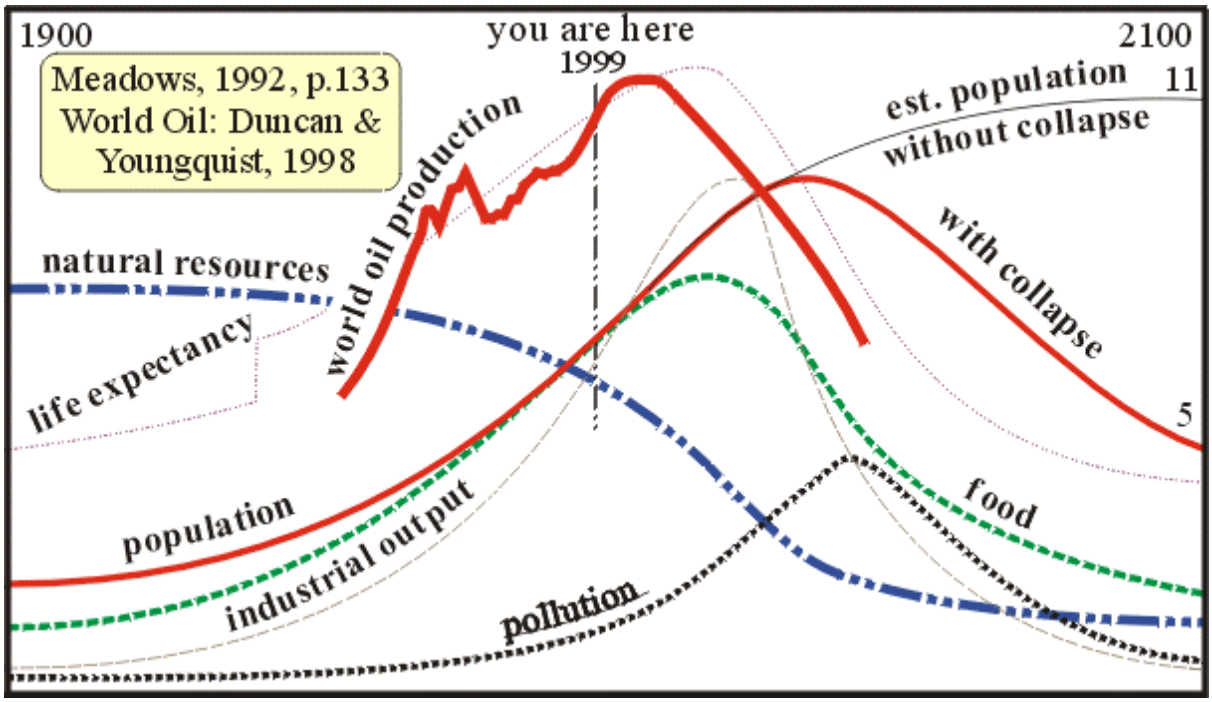
Perhaps the best-known planetary-scale example of a negative feedback is provided in a theory advanced by James Lovelock, an English scientist. Called the *Gaia hypothesis* after the Greek concept for Mother Earth, this view of the world suggests that the earth is a living organism with a complex feedback system that seeks an optimal physical and chemical environment.

Deviations from this optimal environment trigger natural, nonhuman response mechanisms which restore the balance. In essence, according to the Gaia hypothesis the planetary environment is a self-regulating process.

The model of the world envisioned by the Gaia hypothesis is incompatible with that envisioned by the *Limits to Growth* team. Because of the dominance of positive feedback loops, coupled with fixed limits on essential resources, the structure of the *Limits to Growth* model preordains its conclusion that human activity is on a collision course with nature. While the values assumed for various parameters (the size of the stock of depletable resources, for example) affect the timing of the various effects, they do not substantially affect the nature of the outcome.

The dynamics implied by the notion of a feedback loop is helpful in a more general sense than the specific relationships embodied in this model. As we proceed with our investigation, the degree to which our economic and political institutions serve to intensify or to limit emerging environmental problems will be a key concern.

La revisione del 1992: "*Beyond the limits*", Meadows, et al.



Chelsea Green Publishing Company, 1992. ISBN 0-930031-62-8.
Phone: 800-639-4099 or 603-448-0317; FAX: 603-448-2576.

…

"In Scenario 1 the world society proceeds along its historical path as long as possible without major policy change. Technology advances in agriculture, industry, and social services according to established patterns. There is no extraordinary effort to abate pollution or conserve resources. The simulated world tries to bring all people through the demographic transition and into an industrial and then post-industrial economy. This world

acquires widespread health care and birth control as the service sector grows; it applies more agricultural inputs and gets higher yields as the agricultural sector grows; it emits more pollutants and demands more nonrenewable resources as the industrial sector grows.

"The global population in Scenario 1 rises from 1.6 billion in the simulated year 1900 to over 5 billion in the simulated year 1990 and over 6 billion in the year 2000. Total industrial output expands by a factor of 20 between 1900 and 1990. Between 1900 and 1990 only 20% of the earth's total stock of nonrenewable resources is used; 80% of these resources remain in 1990. Pollution in that simulated year has just begun to rise noticeably. Average consumer goods per capita in 1990 is at a value of 1968-$260 per person per year—a useful number to remember for comparison in future runs. Life expectancy is increasing, services and goods per capita are increasing, food production is increasing. But major changes are just ahead.

"In this scenario the growth of the economy stops and reverses because of a combination of limits. Just after the simulated year 2000 pollution rises high enough to begin to affect seriously the fertility of the land. (This could happen in the 'real world' through contamination by heavy metals or persistent chemicals, through climate change, or through increased levels of ultraviolet radiation from a diminished ozone layer.) Land fertility has declined a total of only 5% between 1970 and 2000, but it is degrading at 4.5% per year in 2010 and 12% per year in 2040. At the same time land erosion increases. Total food production begins to fall after 2015. That causes the economy to shift more investment into the agriculture sector to maintain output. But agriculture has to compete for investment with a resource sector that is also beginning to sense some limits.

"In 1990 the nonrenewable resources remaining in the ground would have lasted 110 years at the 1990 consumption rates. No serious resource limits were in evidence. But by 2020 the remaining resources constituted only a 30-year supply. Why did this shortage arise so fast? Because exponential growth increases consumption and lowers resources. Between 1990 and 2020 population increases by 50% and industrial output grows by 85%. The nonrenewable resource use rate doubles. During the first two decades of the simulated twenty-first century, the rising population and industrial plant in Scenario 1 use as many nonrenewable resources as the global economy used in the entire century before. So many resources are used that much more capital and energy are required to find, extract, and refine what remains.

"As both food and nonrenewable resources become harder to obtain in this simulated world, capital is diverted to producing more of them. That leaves less output to be invested in basic capital growth.

"Finally investment cannot keep up with depreciation (this is physical investment and depreciation, not monetary). The economy cannot stop putting its capital into the agriculture and resource sectors; if it did the scarcity of food, materials, and fuels would restrict production still more. So the industrial capital plant begins to decline, taking with it the service and agricultural sectors, which have become dependent upon industrial inputs. For a short time the situation is especially serious, because the population keeps rising, due to the lags inherent in the age structure and in the process of social adjustment. Finally population too begins to decrease, as the death rate is driven upward by lack of food and health services."

THE BASIC OPTIMIST MODEL

Is the portrait of the fate of the world economy painted by the Limits to Growth model an accurate one? Because Herman Kahn and his associates did not think so, they presented an alternative vision in a book titled The Next 200 Years: A Scenario for America and the World. 8 This vision is an optimistic one based in large part on the continuing evolution of a form of technological progress that serves to push back the natural limits until they are no longer limiting.

Conclusions of Optimist Model

The basic conclusion reached by this study is stated in the opening pages of the book [Herman Kahn, William Brown, and Leon Martel, The Next 200 Years: A Scenario for America and the World (New York: William Morrow, 1976)]:

. . .200 years ago almost everywhere human beings were comparatively few, poor and at the mercy of the forces of nature, and 200 years from now, we expect, almost everywhere they will be numerous, rich and in control of the forces of nature [p. 1].

The future path of population growth is expected by Kahn and his associates to approximate an S-shaped logistic curve. This image suggests that an omniscient observer during 1976 looking backward through time and then forward into the future would see rather different things. The retrospective glance would reveal a period of exponential population growth, while the glance into the future would reveal continued growth, but with steadily declining growth rates, until, at the end of the next 200-year period, growth would automatically come to a halt. By that time, however, the population would have increased four times its current level and the average person in the world economy would be earning $20,000 a year (in constant dollars)—a far cry from the 1976 average of $1300 (see Figure 1.2).

To Kahn and his associates, interference with this natural evolution of society would not only be unwarranted, it would be unethical. As they see it, tampering with the growth process would consign the residents of the poorest developing countries—and, indeed, the poorest residents of the developed countries—to a life of poverty, a life without hope. In contrast, they see continued growth as providing continued betterment for both groups; although, due to an expected decline in the gap between the rich nations and the poor, those in the poorest nations would benefit most from continued growth.

The Nature of the Model

The Kahn model is more qualitative than the Limits to Growth model and therefore its structure is less specific. It is not a computer program that simulates the future. Rather, Kahn and his associates devised scenarios they believed to be plausible and then verified that the various components of these scenarios were consistent with each other. The book is filled with reasons why the chosen scenario is reasonable. These lists of reasons frequently include new technologies that, when certain limits are reached, will be introduced. These technologies effectively either remove the limit or buy time until a subsequent technology can remove the limit.

The principles underlying Kahn's work can best be illustrated through the use of two examples: food and energy. One of the sources of collapse in the Limits of Growth model was the inability of food supply to keep up with consumption. Kahn, by contrast, sees food production rising so rapidly as to create an eventual abundance of food. This vision, in turn, depends on some specific sources of optimism: (1) physical resources will not effectively limit production during the next 200 years, and (2) substantial increases can be

expected in conventional foods produced by conventional means, conventional foods produced by unconventional means, and unconventional foods produced by unconventional means.

All of these sources of optimism are related to technological progress. The availability of physical resources can be expanded through the use of better (solar-powered, for example) irrigation systems. Conventional food production can be increased by the spread of better farming techniques and by the development of new hybrid seeds. If soils become depleted or scarce, then food can be raised with hydroponics, a process using no soil. 9 Finally, Kahn points to the development of a single-cell protein as a viable means of converting municipal waste into a food supplement.

A similar approach is taken when describing the world energy future. The authors of The Next 200 Years construct a list of technologies that can provide the transition to solar energy, making the case that solar energy can ultimately sustain a high level of economic activity. The list includes technologies that use coal, either directly or indirectly (such as gas produced from coal); those which exploit the vast world reserves of shale oil; nuclear power (fission, in the near term, replaced subsequently by fusion); and new solar technologies including windmills, photovoltaics, and ocean thermal power.

When all of these lists are combined, the prevailing message is that currently recognized technologies can overcome the limitations envisioned by the Limits to Growth view. The Next 200 Years staff, then, believes that the creators of Limits to Growth erred in being myopic; they were too tied to conventional technologies. When the need arises, they argue, these new technologies will be developed. The cliche, "Necessity is the mother of invention," captures the flavor of the belief of Kahn and his associates that these technologies will be developed as they are needed.

TAKING NATURE INTO ACCOUNT

A Report to the Club of Rome

Wouter Van Dieren, Editor;
***Springer-Verlag,1995**; ISBN 0-387-94533-4; Phone: 1-800-SPRINGER*

INTRODUCTION

In 1972, a report was published by a mysterious club nobody had ever heard of, which shocked the world—a report about the forthcoming collapse of life on earth, not written by some sectarian doomsday prophet but by scientists of high repute, working with that new device of modernity, the computer.

"Limits to Growth," the report was called, and besides a shock it also caused outrage worldwide. Several years after the first phase of environmental awareness and shortly before the first oil crisis (1973), "Limits" brought the message that the world was heading for disaster because of unfettered population growth and industrial expansion, exhaustion of stocks of natural resources, environmental destruction, and food shortages.

"Limits" was based on a so-called simulation model, a mathematical representation of the main variables and their dynamic interactions known as the WORLD III model. Some of the key features of these dynamics are feedback loops, which show that an intervention in one part of a system has unexpected effects on other variables of that system.

The forms of exhaustion predicted in the various scenarios simulated in the model start to emerge in the early twenty-first century, as the world population grows to a peak of 10 billion, per capita food production drops to a mere 15-25 percent of 1970 levels, pollution has risen tenfold, and the most important resources, such as oil and gas, have become depleted. Because of the so-called exponential character of growth and depletion, half-hearted or one-sided measures are of little avail. A drastic program of technological improvement such as energy conservation, for example, achieving 50 percent savings in 20 years against a background of, say, 2 percent growth in consumption, postpones the date of depletion by a mere 3 years.

"Limits" became the subject of heated controversy, and the Club of Rome soon gained the reputation of being a neo-Malthusian movement of doomsayers. The report became world famous, an indication that its message was not only controversial but also supremely recognizable.

Although thousands of scientists have devoted their efforts to the question of how reliable WORLD III was and whether it is even at all possible to forecast the future in this manner, "Limits" has, in our view, come through all the criticism untarnished. In the first place, because the primary aim was not to make a prediction but "to improve the insight," in the words of Jay Forrester, one of the contributing authors; and secondly, because nobody has yet really succeeded in finding fault with the main calculations and the underlying hypotheses.

Since 1972, countless studies and books have been published that confirm the message of "Limits"; but even more extensive than this scientific work has been the worldwide denial of the limits to growth, and the impassioned attempts to remain one step ahead of the imminent shortages through policies of continued economic expansion. Meanwhile, additional new insights have arisen, which not only confirm the impending disasters but also indicate that the limits to growth may well have been exceeded and that the world has been in a state of decline for some years already. The most important study in this context

is For the Common Good (1989), in which Daly and Cobb develop an information theory to replace or supplement the incomplete data function of what is known as the Gross National Product. By processing U.S. statistical data on some twelve so-called welfare indicators, they drew the conclusion that for the last twenty years the link between production growth and the creation of welfare has become progressively weaker; prior to that date, production growth had achieved exactly what Adam Smith foresaw in 1752: the addition of value so as to indeed create the "Wealth of Nations." In the 1970s this link began to be lost, however, and this process is proceeding at such an accelerating pace that we are now confronted with the curious phenomenon of production growth leading to a decline in welfare; stated differently, the limits to growth have been reached without us even noticing it, because we have been interpreting the figures wrongly.'

Our aim is to undertake a further analysis of the concept of growth within this framework; and above all, of the opposition to information that is critical of this growth. "Limits" evoked extreme opposition, but nonetheless there is fascination worldwide with the Club of Rome and its first and greatest message. The latest insights tell us that their message is not only being confirmed daily, but that it has in fact been surpassed by reality. The limits to growth no longer merely lie ahead, in the future; they are with us today, and have been for the last twenty years.

The international community does not know how to handle this reality, however. Discussions in international forums where the necessity of growth or its significance are challenged inevitably lead to emotional scenes, and all the agendas of all the world's political and economic bodies call for growth in the restricted sense of the word, because of an unabashed conviction that this is always good for the world. But this is simply not the case: a steady growth of output does not necessarily lead to more jobs or a better environment, it does not combat famine or promote social security, neither does it improve education or public health. On the contrary, most of these aspects of welfare seem to suffer under unrestricted economic expansion, which has become a law unto itself.

The main thrust of opposition to "Limits" lies in the belief that economic growth is a kind of law of nature, which humanity must obey. Since Adam Smith invented the Invisible Hand, this power has been a guiding principle for all those who believe that free trade, or the market, will ultimately lead to a natural order of things, a moment when everything will fall neatly into place: free trade will provide income and employment, welfare for all, equality, peace, and a future. In this way of thinking, the problems outlined by "Limits," are a result of obstacles to free trade—and if things are not well with the world, that is a logical consequence of these obstacles; for example, too much government intervention, too high social benefits, too much environmental and labor legislation, an overly expensive quaternary sector, and so on. Allow the free market to do its curative work, in other words, and the Divine ordination of the invisible hand will balance out the world economy.

It is no coincidence that this kind of metaphysical notion was a nursemaid to the industrial revolution, nor that it is part and parcel of modern economics. Adam Smith certainly intended the Invisible Hand to serve as a metaphysical, divine principle, which effortlessly took over the role of Divine Providence, on which western humanity had focused its aspirations until the Enlightenment. The Enlightenment blocked this Providence, because it called for science, technology, and mechanization, and thus distracted attention from God's will. By introducing the invisible hand, Smith took up the deistic thread once more; now the economy too, or precisely the economy, was to be driven by supernatural laws, and in the industrial age, too, the role of God would remain of decisive importance.

It is our conviction that this metaphysic is still as topical as ever. The opposition to "Limits" is so strenuous that clearly forces other than science are at work. One would expect

humanity to take up the challenges of "Limits" and set up an international organization to halt the decline. The opposite has been the case. A veritable crusade of economic expansionism has been unleashed, as if to prove that "Limits" was pessimistic and in error, and everywhere the conquests of this crusade are praised as providing the desired proof, such as the economic miracles embodied in the Asian growth figures. And for the sake of convenience we then ignore the enormous price of these miracles, the ecological destruction, the plundering of the surrounding oceans, the consumption of the region's natural capital, the -underpaid workers, the absence of social security. And while these miracles are seen as proof of the power of the invisible hand, nobody is prepared to answer the question of why the same metaphysic has caused war and famine in Africa. Does the invisible hand pick its favorites? Or are the Africans paying the penalty of disobeying the laws of natural economic ordination? Or is it the case that here—and in the former Soviet Union—the law of Keynes holds: that suffering is a precondition, albeit temporary, for later success?

It is of crucial importance to state that the invisible hand does not exist, that there are no laws of economic ordination, that although the notion of economic growth can be defined, its political usage is above all rhetorical, that economics is not really a science but a set of theories, and that every attitude towards the limits to growth is a question of culture, of choices, free will, and—possibly—rationality. There is no inevitable fate compelling humanity towards unlimited free trade, over-exploitation of nature and labor, exhaustion of resources, and finally towards a war of all against all (Hobbes) to gain control of the last remaining resources and food. Economic thought differs from culture to culture, and within each culture even from school to school, from university to university. There are myriad options to choose from, and none of them need satisfy a single requirement of a metaphysical nature. What is of key importance is that we rid our economies of hypocrisy, and this forms the subject of the present Report.

The main hypocrisy lies in the system of National Accounts that has been employed in the Western economy for nearly half a century now, with partial implementation in most other countries. The technical background of the National Accounts is described elsewhere in this Report; in this introduction, our aim is simply to set out why we consider this topic to be so vitally important in the debate on growth and the limits to which it is subject.

Until 1945, the notion of economic growth was used differently from today. As elaborated in Chapter 3, it was not until about 1932 that several economists came up with the idea of measuring a country's economic performance and not until 1950 that the ensuing system was introduced in most industrialized countries. It was thus inevitable that the costs of production growth would be encountered, costs that for decades the theory had termed negative external effects. In former times these effects had been happily accepted, but when production as a whole is encapsulated in a profit-and-loss account, the costs, or negative expenditure, automatically appear on the balance sheet. And that is where we stand today.

Surprisingly enough, users of National Accounts have long remained deaf to recommendations to subtract these costs from the profits, despite an information load that has become so heavy in recent years that for some economies the point now appears to have been reached whereby the costs are perhaps even greater than the profits— without this being reflected in the National Accounts. This is of vital importance for the debate on the limits to growth, because these economies continue to literally count themselves rich, while poverty is on the rise, or in other words because the subtracted value is higher than the added value. Phrased differently: the economy is being kept afloat on paradoxical information, not even on incompleteness, and the abuse of the National Accounts is at the core of the matter.

The notion of the National Account is not employed in everyday political parlance; instead, the public at large hears the terms Gross National Product (GNP) and its derivative, Gross Domestic Product (GDP). This GNP has gained metaphysical significance: it stands for the mark given to the country by the Invisible Hand and thus even acts as a symbol of the degree to which that nation has been elected in the Divine ordination that steers the Invisible Hand. In this vision of things, one has subjected oneself to the natural laws of the economy, and the nation is seen to have passed the examination if the number attached to the GNP is positive: one, two, or three percent growth per annum, whatever that may mean. Orio Giarini has made a comparison between the effect of GNP in heaven, in hell, and on earth. He describes the complication of Industrial Revolution accounting by the paradox of hell and heaven, when applied to the notion of scarcity. Heaven, being probably blessed by an infinite stock of goods and services of all sorts (material and spiritual), knows nothing of scarcity. Economics and the economy therefore do not exist. There are no prices and there is no money, since everything is readily available without any restriction or work. Heaven, then, must be something very different from earth, but it is also a place of zero GNP. Hell, as the opposite of heaven, is a place which consumes a lot of energy in maintaining its celebrated image and presumed activities. It therefore probably needs to develop a huge value added which nobody has ever tried to measure: GNP must be very high indeed! On our earth, the maximum possible achievement in the fight against scarcity is to create an abundance in as many sectors as possible. But human and economic development also entails identifying and coping with new scarcities. Scarcity is ultimately the hallmark of the system of disequilibrium within which human endeavour is destined to operate: it is the sine qua non of man's quest for fulfilment, so Giarini says.

One of the major paradoxes in value accounting and in defining the development of wealth is that an increase in real wealth corresponds in some cases merely to an increase in the cost of pollution control (e.g. investment for waste-disposal and environmental purposes, which is clearly a deducted value type of cost), while on the other hand, many real increases in value are underrated. For instance, GNP growth figures published each year by governments indicate that the economy has grown by so many percent. However, a large part of this growth is in fact absorbed by factors which do not necessarily add to our wealth, while other factors that represent net increases in our well-being are not, or are only inadequately, taken into account.

Going back to the paradox of hell and heaven, one of the reasons for our reluctance to reconquer paradise is that in some weird way we seem to be more at ease with hell.

Giarini believes it important to define a level for the wealth of nations in terms of stock, its increase, depletion, use, conservation and its diversification. Measurements of value added are important for the organization of an industrially productive system, which is an important subsystem of the economy as a whole. But is only partially relevant to the business of measuring, targeting, and organizing the wealth of nations.

If the growth of GNP is three percent, but the uncalculated costs of output are some four percent of GNP, then at least we know that the quality of life in that country is declining. To argue that these costs be discounted is to argue for introduction of a system we term SNI, Sustainable National Income, a national income in which interest and yields are indeed added up, but in which depletion of resources and nature are subtracted from the income, as it were. Even then, the problem remains that even a corrected GNP still says nothing about the real value and dignity of a society. However (so say the politicians) without a growing GNP the country will become a second-rate nation, and so we must subject ourselves to interventions that are progressively demolishing the whole postwar social fabric. We are being colonized by the economy, as it were, and that was certainly not the original aim.

In his dialogue on wealth and welfare, Giarini points at the many paradoxical reasonings in the theory of wealth accumulation. Classical economists, and in particular Ricardo, were well aware that the methods for the accounting of economic wealth that they were devising were not really comprehensive of the real level of wealth of an individual or a country. A clear distinction was made between the notion of riches on the one hand and of wealth on the other. There was even an implicit acceptance that there could be situations where an increase in wealth would not correspond to an increase in riches.

However, these considerations remained secondary because the main problem during the Industrial Revolution was to identify the most dynamic system for increasing the wealth of nations, i.e. the industrialization process, and to concentrate on its development. Inconvenient discrepancies between wealth and riches were considered of minor importance. The writings of classical economists and of some of their later commentators were very much influenced by the fact that the first formulation of economic theory was a description of the industrialization process: the priority, which was quite adequate for this purpose, was to measure a flow of goods and the value added, whether supply-, or demand-based.

In the Service Economy, where the industrialization process per se is no longer identified as the prime mover in increasing the wealth of nations, the problem is quite different and the contradiction between wealth and riches becomes much more important.

The divergence of the notion of riches from the notion of wealth corresponds to what can be called the development of deducted values in the modern economy. Increase in these deducted values stems from the increasingly higher allocation of economic resources to activities which do not add to the real level of wealth (or of riches), but which are in fact absorbed by rising costs of the functioning of the economic system.

Let us take an example. In many households, the level of wealth is sharply increased by the introduction of washing machines, other electrical appliances, and new tools that make housework easier. But with the increased level of wealth comes an increase in the amount of waste produced in the home, which, during the 1960s, led the research divisions of companies producing household appliances to develop new machines for getting rid of kitchen waste. In a traditional sense, a waste shredder (or a waste compactor) machine adds to wealth, whereas in reality, it is merely coming with the increased nuisance at one place in the system (the private house) and creating a system breakdown elsewhere (at the sewage or waste-treatment plant). In addition, we have not become richer by having a machine to destroy garbage, as compared to when we had no garbage to get rid of. But, according to the economics of the Industrial Revolution, our wealth has increased.

Examples of this trend which began in the 1960s abound. Air and water pollution are obvious cases of diminishing real wealth (or of diminishing riches). If money is invested to de-pollute water or to develop alternative solutions such as bottled water, special reservoirs for drinking water, or swimming pools next to a polluted seashore, we are once again confronted by Catch-22 situations where investments are necessary to compensate for riches lost through, for example, pollution: these investments are not net added value to our wealth!

The growing discrepancies between levels of wealth and riches (or the contradiction between economically accounted wealth and real wealth) clearly indicate the need to refer increasingly to stock, i.e. variations in real wealth, as a substitute for the measurement of production flows (the bathtub example). Furthermore, there is also a problem of matching real added values to deducted values. A new conceptual approach to systems for measuring the real results will have to replace the simple analysis of the costs of an isolated activity.

The notion of deducted value implies the need to take into consideration the notion of negative value. In terms of economic analysis, this is already a step in the right direction, given that in many cases the negative side of economic activities has simply remained unaccounted for. Diminishing increase in an economic situation has in fact to be distinguished from a net negative process. Measuring wealth through flows that do not fill a bathtub, or even worse, that are shut off, excludes the notion of negative flows. Only by looking at the stock can positive and negative variations be measured and a decision taken as to whether the flows produce values added or values deducted.

Besides the formal conversion of the GNP into an SNI, the meta-message of this report concerns the necessity of defining economics in a final tuning way, by pointing at not only the paradoxes but also at its diversity. Economics is not a law of nature, and when it comes to output, income growth and distribution, resource use and welfare development, any system can be chosen and molded because what are involved are primarily questions of culture, choices that are made and implemented by human beings, with the economy merely a tool to help us, nothing more. Economics should then be—and can be— an instrument to define the truth.

WHAT HAPPENS IF WE FAIL IN THIS QUEST?

In the first place, we would reiterate our original message; in the words of Jay Forrester: "Over the last hundred years, life on earth was dominated by growth. Growth of population, of production, of income and capital formation, of exhaustion and pollution. This growth is going to stop and must stop, and the only question is by what means? Voluntarily, by government and free will, or through natural processes, which means collapse and disaster?"

Ultimately, this is the vision of the future, and many elements of it have already become reality in the world around us: collapse of life-support systems, of communities, regions and nations, lack of food, scarcity of water, climate change and, ultimately, war. Of the approximately 100 wars now being fought in the world, more than 70 percent originate in part in exhausted resources and collapsing life-support systems. This is the ultimate consequence, clearly confirmed by such authors as Meadows, Kennedy, Kaplan, and c others (see References).

The second consequence consists in the mild precursor of this collapse, the process of individual enrichment of the few at the cost of growing public poverty, the decline in wealth and welfare to be observed everywhere today, now methodologically confirmed by the aforementioned studies of Daly and Cobb.

It is important to hold modern Western political practice up to this light, a practice consisting of ever more austerity programs to secure the integrity of purchasing power or of individual consumption, to which political affairs are being sacrificed.

Because the dominant focus of technology is to substitute labor (a process known as productivity growth), an imbalance in income growth sets in between those sectors where productivity rises—in other words, industry—and those where it cannot; in health care, education, justice, and public administration, for example. Wage demands in these sectors cannot be absorbed by rising output, although due attempts are made by amalgamating schools, closing senior citizens' homes and hospitals, abolishing police corps, and overloading the courts. The ultimate outcome is that the modern welfare society is disappearing, to the benefit of growing private consumption and the enrichment of a small elite. The neoliberal model thus becomes the future: miserable public services, bad public transport, decrepid and unsafe inner cities, overcrowded and ever more unhygienic

hospitals, impoverished senior citizens; unmotivated, poor education; neglected culture, minimization of scientific research, and environmental neglect. Every government today holds up this agenda, and it is no wonder that they are all concerned above all with cranking up production growth, in the hope that this will generate funds with which to compensate for the new poverty. That may have worked with growth in the past, but it does so no longer, because an ever greater proportion of each new round of production growth consists of negative economy: compensation and repairs, processing of waste and controlling of complexity, in other words expenditure that is taken to be income. The contemporary example par excellence is in those countries which today suffer from war, guerrillas, and dictatorship, and where the arms industry is earning masses of money and, when one day there is peace, so will the demolition companies, the clear-up gangs, the contractors, the international consultancy agencies, the whole redevelopment business. When, twenty-five or fifty years from now, the country has been redeveloped to its condition prior to 1990, no net achievement will have been made, but the growth figures will be high.

This is the fate of every economy that has exceeded the limits to growth, and this means that in those countries, monetary policies are leading to accelerated demolition of both the welfare state and the cornerstones on which production growth rests.

Both forms of collapse are the result of the hypocrisy and the metaphysic bound up in the economic information. This report is about the unmasking of that hypocrisy and is thus a plea for a form of rationalization that in the world of economic metaphysics has until now proved extremely difficult. Economics can be a beautiful instrument when applied in its original meaning: to put the house (oikos) of mankind in order.