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U.S. ECONOMIC GROWTH FROM 1976 TO 1986:
PROSPECTS, PROBLEMS, AND PATTERNS

Volume 7—The Limits to Growth

STUDIES

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LETTERS OF TRANSMITTAL

DECEMBER 15, 1976.

To the Members of the Joint Economic Committee:

Transmitted herewith is the seventh volume of the Joint Economic Committee study series entitled "U.S. Economic Growth From 1976 to 1986: Prospects, Problems, and Patterns." This series of over 40 studies forms an important part of the Joint Economic Committee's 30th anniversary study series, which was undertaken to provide insight to the Members of Congress and to the public at large on the important subject of full employment and economic growth. The Employment Act of 1946, which established the Joint Economic Committee, requires that the Committee make reports and recommendations to the Congress on the subject of maximizing employment, production and purchasing power.

Volume 7 comprises three studies which examine whether there are "limits to growth" in the United States and if so, what their nature is. The authors of the studies were Mr. Herman Kahn, Profs. Fred Allvine and Fred Tarpley, and Prof. Nicholas Georgescu-Roegen. The Committee is indebted to these authors for their fine contributions which we hope will serve to stimulate interest and discussion among economists, policymakers and the general public, and thereby to improvement in public policy formulation.

The views expressed are those of the authors and do not necessarily represent the views of the Committee Members or Committee staff.

Sincerely,

HUBERT H. HUMPHREY,
Chairman, Joint Economic Committee.

DECEMBER 10, 1976.

Hon. HUBERT H. HUMPHREY,
Chairman, Joint Economic Committee,
U.S. Congress, Washington, D.C.

DEAR MR. CHAIRMAN: Transmitted herewith are three studies entitled "Current, Medium, and Long-Term Prospects" by Mr. Herman Kahn, "The New State of the Economy: The Challenging Prospect" by Profs. Fred Allvine and Fred Tarpley, and "Economics and Mankind's Ecological Problem" by Prof. Nicholas Georgescu-Roegen. These three studies comprise volume 7 of the Joint Economic Committee's study series "U.S. Economic Growth From 1976 to 1986: Prospects, Problems, and Patterns." This series forms a substantial part of the Joint Economic Committee's 30th anniversary study series.

These studies make very clear two things concerning the limits to growth debate: First, the debate still exists, and second, the debate has evolved to where the primary types of limits being considered are

not physical ones but rather cultural, economic, social and moral in nature. These papers, like many others published in this series so far, emphasize the importance of noneconomic factors in determining the rate and pattern of economic growth.

For the next decade, which is the focus of this study series, Herman Kahn foresees continued economic growth but he is not so sanguine in his vision of the years leading up to the year 2000. His optimism is based on his assessment that the forces making for growth are at the moment so strong and have such great intrinsic momentum that in spite of all the roadblocks thrown in their way in the last decade or so, they are almost certainly going to triumph in the short run. One of these roadblocks which he discusses is the limits to growth perspective, a "movement" that he asserts now seems to be in retreat after peaking in early 1976. The principal reason he cites for the rapid and pervasive spread of this perspective was that so many special interests and social groups really wanted to believe it, especially what he terms the "New Class." Rather than dismissing these "New Class values," he goes on to assert that these types of changing values, attitudes and beliefs will be the social and cultural factors that will intervene long before physical constraints set serious limits on either population or economic growth. Perhaps the most important and basic of these social and cultural factors, according to Kahn, is simply satiation—or at least a satisfaction of the most urgent needs and a corresponding change in priorities rather than a change in values though the latter is also important. He specifically cites 13 trends or new emphases which can be identified that seem particularly likely to play an increasing role in U.S. values, priorities, and attitudes, eventually causing economic growth to slow.

Professors Allvine and Tarpley provide a much more negative assessment of future economic growth prospects. They maintain that despite considerable effort, few careful examinations have identified what they feel are the fundamental causes for the U.S. malaise. Their basic thesis is that in the late 1960's and early 1970's, certain fundamental conditions supporting an expanding economy changed, and we have entered into a new period. The U.S. economy they feel is suffering from diminished support of several of the major sources of long-run economic growth. They discuss in considerable detail three major sources: (1) A shift in societal attitude from a "pro growth" to a "conservation ethic"; (2) a decline in the pace and impact of economic innovation in U.S. industry, wherein many of the spectacular postwar World War II growth industries are maturing and new innovations are not occurring in significant enough numbers; and (3) the rapid rise in the cost of energy that fuels our economy which is expected to continue rising for years to come. They make four recommendations to aid in the reconciliation to these new conditions, among which are: (1) That the fires of excessive expectation must be banked and society has to grow to expect less in order to have more and (2) societally oriented laws must be evaluated not only in terms of the problems they are designed to correct, but also from the standpoint of their impact on the economy.

They challenge economists to leave the sophisticated world where they have dwelled the past 30 years in order that they may help in

solving the critical long-run problems which usually are on the supply side.

Professor Georgescu-Roegen presents a theoretical argument substantiating the limits to growth thesis. The crux of mankind's ecological problems lies in the fact that our terrestrial dowry is finite and can be used only once. Economics, he feels, cannot help in solving it. This stems from the fact that the role played by natural resources in the economic process is completely ignored. Having said this, he argues that we cannot avoid the necessity of keeping books in terms of energy and matter. In the ultimate analysis, he asserts, the economy of resources hinges mainly on demand. When things become increasingly scarcer, we must do with less. He states that there are numberless activities which almost invite us to eliminate or slow them down. Also, the developed must come to realize they are over developed. Since growth is wrong ecologically, decrease according to him appears to be the right prescription in some parts even today, and in all parts in the long-run and on the average.

The Committee is deeply grateful to these authors for these extremely challenging papers. Mr. Kahn is Director of the Hudson Institute, Professors Allvine and Tarpley are faculty members at Georgia Institute of Technology, and Professor Georgescu-Roegen is with the Regional Research Institute at West Virginia University.

Dr. Robert D. Hamrin of the Committee staff is responsible for the planning and compilation of this study series with suggestions from other members of the staff. The administrative assistance of Beverly Mitchell of the Committee staff is also appreciated.

The views expressed are those of the authors and do not necessarily represent the views of the Members of the Committee or the Committee staff.

Sincerely,

JOHN R. STARK,
Executive Director, Joint Economic Committee.

CONTENTS

| | Page |
|---|------|
| Letters of transmittal..... | III |
| CURRENT, MEDIUM, AND LONG-TERM ECONOMIC PROSPECTS | |
| By Herman Kahn | |
| Summary | 1 |
| A. Introduction and overview..... | 2 |
| B. The current pessimism, sense of illegitimacy, and general anxiety and malaise | 7 |
| C. Some comments on inflation..... | 11 |
| D. Expectations, morale, and self-fulfilling and self-defeating prophecies..... | 15 |
| E. A realistic image of the current world-wide situation and future trends | 17 |
| F. But why should the growth rate continue during the 1976-86 period and then slow down so soon?..... | 21 |
| Annexes: | |
| 1. The current inflation in perspective..... | 26 |
| 2. Thirteen "new" emphases and trends for U.S. values, attitudes, and goals..... | 37 |
| THE NEW STATE OF THE ECONOMY: THE CHALLENGING PROSPECT | |
| By Fred C. Allvine and Fred A. Tarpley, Jr. | |
| Summary, conclusion, and recommendation..... | 46 |
| The analysis..... | 50 |
| From a pro-growth to a conservation ethic..... | 50 |
| Innovation and economic growth..... | 53 |
| Escalating energy costs..... | 58 |
| Economics profession and the new reality..... | 60 |
| ECONOMICS AND MANKIND'S ECOLOGICAL PROBLEM | |
| By Nicholas Georgescu-Roegen | |
| Summary | 62 |
| I. The mechanistic philosophy of standard economics..... | 65 |
| II. Thermodynamics and the nature of the economic process..... | 68 |
| III. The necessary dualism: Energy and matter..... | 71 |
| IV. The general flow matrix of the economic process..... | 75 |
| V. The ABC of bioeconomics..... | 77 |
| VI. Bioeconomics and economics..... | 82 |
| References | 90 |

CURRENT, MEDIUM, AND LONG-TERM ECONOMIC PROSPECTS

By HERMAN KAHN*

SUMMARY

With reasonably good luck and good management, the U.S. economy should be able to grow, on the average, almost 5 percent a year from 1976 to 1986. Starting from a GNP of \$1 $\frac{1}{2}$ trillion in 1976, the U.S. economy would then reach about \$2 $\frac{2}{3}$ trillion in 1986 (in fixed 1976 dollars)—i.e., a 60 percent increase in 10 years.

This projection is optimistic and perhaps more of a goal than a prediction, although with proper policies over the next two-three years—and reasonable luck—I would argue the chances of this prediction coming true are about even. But the caveat is important.

We deal with the likelihood of the above scenario by considering the following three phases:

1. Recovery from the current recession.
2. Continuing problems of inflation and confidence.
3. Basic economic variables and trends, and changing values and priorities (such as working force, productivity, the general psychological climate or milieu, changing values and emphases, government regulations and other interference, etc.)

With regard to the first point, the most obvious scenario for some degree of financial collapse would be a program by the incoming administration of excessive stimulation of the economy, a “bailing out” of the cities, a series of anti-business acts and regulations, and ineffective price and wage controls. Fear alone of the above scenario could inhibit recovery—its actuality or imminence could cause a financial disaster.

Clearly, the new administration will do things in the above direction, but hopefully only to a degree that will leave the many claimants “sullen but not mutinous.” Otherwise, one can confidently predict inflation and a financial collapse, which might be short but could be very severe. Savers, lenders, borrowers, and investors are now all very skittish, and there is an unprecedented technology and institutions for touching off a panic disintermediation or other disastrous reaction if there is a general apprehension by the financial community

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of the above measures. The possibility of insufficient stimulation I would regard as relatively low, but certainly conceivable.

With regard to the second point, "inflation and confidence," to some degree it is two aspects of the same issue, but to some extent they are separate. If there were no inflation and long-term money were available at 4 percent in guaranteed mortgage loans or to AAA Corporate borrowers, millions of families would be willing to borrow at this 4 percent rate and millions of loans would be available at the same rate. Similarly, business would find many projects which would look reasonable at 4 percent. One can argue that the current nominal 8–10 percent is about 4 percent in real terms since an inflation rate of 5–6 percent is anticipated, but, because of current institutional arrangements, it does not work like this. Both borrowers and lenders are subject to real penalties because of the large difference in nominal and real interest rates.

It should be noted that in a modern economy consumers can cut their expenditures by a factor of two and businessmen can defer most of their capital improvements if they lack confidence in the general economic outlook. Without confidence, no early recovery will occur.

Let us turn now to the third point. Most of the objective variables (expanding working force, possibilities for increasing productivity, pent-up domestic and foreign demand, unexploited technologies, and so on) would argue for a high rate of increase in production. But in addition to the first two phases or issues, what we call the new emphasis on such things as risk aversion, localism, health, safety, comfort, protection of environment and ecology, and so on—and accompanied by anti-technological, anti-industrial, anti-business attitudes and acts—may slow down economic growth. We argue that this was of increasing importance from 1965–1975, should become less important for awhile, and then come back very strongly, particularly because of the influence of what we call the New Class, which is temporarily in abeyance, but is apt to reemerge within the decade stronger than ever.

A. INTRODUCTION AND OVERVIEW

We are concerned here mostly with the rate of growth of the U.S. economy during the next decade, 1976–1986. We start by assuming that, with reasonably good luck and reasonably good management, the U.S. economy *should* be able to achieve something like the following: (1) produce about 1 and $\frac{2}{3}$ trillion dollars of goods and services in 1976; (2) grow a little under 5 percent (at about 4.8 percent per year) from 1976 to 1986. This would yield a 60 percent increase in the GNP in ten years or an additional trillion dollars over the current $1\frac{2}{3}$ trillion (all in fixed 1976 dollars).

We would not expect this high growth rate to continue; in fact we would argue that the next 15 years are likely to see an increase of only about 50 percent or a GNP of about 4 trillion dollars in the year 2000 which is a relatively sharp decline to less than 3 percent (actually 2 and $\frac{3}{4}$ percent) average annual growth.

The ten-year projection is obviously an optimistic estimate—perhaps more of a goal to aim at than a prediction. The 10-year goal could be achieved if we would average 6 percent growth in the next four years and 4 percent for the next six years. This would be consistent

with a picture in which there is a steady 4 percent basic growth in the economy for the entire decade. Output would be augmented in the first four years by putting to work resources and manpower which have been idled by the recession, thus increasing the basic 4 percent rate to a 6-percent rate.

Actually we would not assume that growth during the decade would be smooth. Rather we would expect the postwar pattern of a recession every 5 years or so to continue, which would suggest two small recessions in the decade. And we argue in the text that if we try to avoid these small recessions, we would risk getting a somewhat bigger one, even if somewhat latter.

How sure am I of these predictions? Obviously quite unsure, though I would certainly be surprised if growth were very much higher during the decade (say 20 percent higher). I would not be very surprised if it were much lower. One can easily write scenarios for the future of the United States in which the average growth is 1 or 2 points below that assumed, or even lower.

It should be clear that a number of things could cause low growth rates. First and most obviously, the U.S. economy might not recover fully from the current recession; in particular, we might enter an extended period of economic stop and go or stagflation. The first would most likely be caused by a burst of inflation which, in addition to its direct effects, had a disastrous impact on business and consumer confidence. This in turn would have catastrophic effects on the economy—at least in the short run. Equally possible is an extended stagflation. Most likely this would be caused by an acceptance of the current 5 percent inflation as livable, but not adequately correcting for it. Low growth could also result from a bad environment for business, perhaps as a result of government acts of commission and omission, or an intensification of the recent anti-growth psychological milieu.

Although these and other possibilities have been extensively discussed already, including by hearings before the Joint Economic Committee, it still seems to me that some very major points are often overlooked or underemphasized.

For example, many current projections assume that the GNP deflator will continue to increase at about 5 percent over the next decade and that construction costs will go up by about 10 percent. The implication is that we can live with these two trends, even without doing anything special to correct for the inflation, such as some additional indexing. However, my basic assumption is that the inflation can and should be brought down to roughly a zero rate. I would also argue that temporary indexing would help to bring the economy down to a soft landing from the current inflation—i.e., the high growth rate scenario assumes that the inflation is dealt with either by controlling it or by suitable indexing or other suitable arrangement.

Since business and consumer expectations about the future play a central role in the actual performance of the economy, prophecies can play both self-fulfilling and self-defeating functions. Some aspects of this phenomenon seem to us insufficiently discussed even though many businessmen seem well aware of them. Thus, while anticipating inflation may well provide momentum for further inflation, it also actuates some political and economic mechanisms which may force a decrease in inflation, particularly if at the same time some appropri-

ate indexing helps business and individuals avoid the need for hedging against continued or increased inflation.

The complex effects of current unemployment on business and consumer confidence are both extremely important and usually overestimated. Issues of the differences between list prices and transaction prices also merit attention, in terms both of effect on the indices (which in turn affects expectations) and the fact that the differences may be quite large—often depending upon expectations about the possibility of price and wage controls (fear of these can induce artificially high list prices and much unofficial or hidden discounting).

There are of course many other uncertainties and changing trends. Most important in the long run, and almost as important during the decade, will be the effects of changing priorities and values. This is an extraordinarily complicated subject. We would like to oversimplify our discussion here by couching much of it in terms of an artificially simplified clash between what we call “New Class”¹ values and traditional values.

The New Class largely comes from upper middle class origins, but whose income and status are largely gained through the possession of knowledge, language skills, and/or formal academic education rather than from being a member of privileged families, having property, possessing entrepreneurial or business skills, or working with one’s hands (except for artists of various sorts). Expressly excluded are almost all blue collar workers and many of the white collar workers at the lower levels of the hierarchy or even professionals who tend to work with relatively hard and “practical” skills such as dentists, civil engineers, and geologists. We might also note here that the “New Class” includes much of the educational and media establishments and that part of the government and business world which is closely allied to these establishments. From the “ethnic” and religious point of view, they are often drawn from liberal members of mainstream Protestant sects (Episcopalian, Presbyterian, Northern Methodist, Congregationalist, Quaker, and Unitarian).

They also include many liberal Reformed or secular Jews, the Ethical Culture society and Catholics who are now assimilating to emerging upper middle-class standards. The New Class is not identical with the liberal establishment or even upper middle class liberal intellectuals, though they are largely a sub-group of these. For our purposes, we can contrast the New Class with what we call square or middle class Americans.²

While many in the New Class are not indifferent to growth, many of them would be willing to see it slow down or would give it lower priority than what we call in the text the New Emphases and Trends.² By contrast, the middle class on the whole puts the highest priority on traditional values as listed in what we call the Traditional Levers² and would place much less priority and effort on the New Emphases and Trends.

We believe that, in the long run, most of these New Emphases and Trends will be given an overwhelming priority by most of the Ameri-

¹ The term was coined by Milovan Djilas to denote the upper levels of the bureaucracy and intelligentsia in Yugoslavia. It has been used by Irving Kristol and B. Bruce-Briggs in much the same way we do here.

² The reader might contrast the list of New Emphases and Trends on annex 2, p. 37, with the Traditional Levers as set forth on p. 43 in the same annex.

can people; this is one of the main reasons for the slowing down of economic growth in the long run. The issue dividing the two groups is probably more a question of timing and tactics and short run goals than basic principles.

It is very simplified to talk about these groups as if they were homogeneous and distinct or as if they were the only two actors in what is an extraordinarily large and complex number of other groups and players. But we do not believe that the discussion of basic issues is terribly distorted by this simplification, though it will be very annoying to many.

In order to attain the economic projections given, it will be necessary, first of all, to restore the idea of legitimacy and desirability of economic growth and technological advancement and to eliminate or curb the common current mental attitude that encourages low morale or hostility to economic growth and technological advance—that in effect acts as a kind of sand in the gears in slowing down or obstructing movement.

Such a change—at least in the short run—seems plausible to me because, in effect, I expect a counterreformation in American political, social, and cultural life that will tend to counteract or correct many of the recent excesses of the New Class and its allies in both fiscal, regulatory, and morale matters. As a result, there should be less deficit spending at every level of government and a reasonable and practical due process should become a substitute for confrontation and delaying tactics. Furthermore, measures to facilitate investment in the needed infrastructure and other facilities would be encouraged—at least for the next decade or so. Finally individual and group motivation and morale should be greatly improved.

The projection also depends upon certain technical factors such as a rather large increase in the working force, a relatively low dependency ratio in terms of the number of old people and young who have to be supported by the working population, and other favorable factors (such as a continued emphasis on income over leisure by the bulk of the work force) many of which begin to change by the end of the decade or soon afterwards.

Finally, I would argue that regardless of the result of the election, there is likely to be a continuation of current policies (even if there is a change in rhetoric) which gives high priority to controlling inflation. This current policy includes a reluctant willingness to tolerate—at least for a time (in part because it probably cannot be prevented)—relatively high unemployment, relatively low utilization of capacity, relatively tight money, a moderately tight fiscal policy, and a “rifle” (structural) approach to unemployment rather than a “shotgun” approach. Actually we would argue that any early attempt to promote much faster growth would bring about a new outburst of inflation which in turn would cause a new recession somewhat more intense, though not necessarily longer, than the recent one.

We can summarize much of the above in Table 1, a slightly revised version of the following document which was originally published in 1975.

TABLE 1.—Two 1975 Economic-Social Scenarios for 1975-1985

| EXTRAPOLATION OF MANY 1975 EXPECTATIONS AND DISCUSSIONS | HUDSON PREFERRED SCENARIO |
|---|--|
| 1. U.S. boomlet and bust (because of insufficient stimulation of economy, credit crunch in late 1976, two-digit inflation in 1977,) or just the expectation of any of these. | 1. Relatively steady U.S. recovery and growth |
| (a) GNP growth rate: 4 to 6 percent in 1976 Low growth or recession in 1977-78 | (a) GNP growth rate: 6 to 7 percent in 1976. About 5 to 6 percent 1977-80. About 3 to 5 percent 1981-85. |
| (b) Inflation rate: >5 percent in 1976 ~10 percent in 1977 Stays high (5 to 10 percent) 1978 to 1985 | (b) Inflation rate: 5 percent in 1976. <5 percent in 1977. Low 1978-80. Could be ±1981-85. |
| (c) Unemployment rate: 8 percent in 1976 >9 percent in 1977 Uncertain 1978-1985 | (c) Unemployment rate: Below 8 percent in 1976. Declining to 5 percent in 1980. Uncertain 1981 to 85. |
| 2. Energy | 2. Energy |
| (a) Little expansion and conversion to coal. OPEC oil price continues gradual real increase — reaches about \$15 in 1980 and about \$20 in 1985 (in 1974 dollars). OPEC export volume reaches about 35 million barrels per day or more. | (a) Some conversion to coal and beneficiated oil. OPEC export volume stays below 35 million barrels per day. Average real OPEC oil price (including concealed discounts) stays roughly constant in terms of 1974 dollars. |
| (b) U.S. Project Independence drifts on inconclusively: No large expansion of U.S. coal production or infrastructure (ports, railroads, etc.) Problems of nuclear powerplants (safety, pollution, siting problems, waste disposal, plutonium processing, other regulatory red tape) unsolved. Localism increases and prevents many other energy projects. | (b) Project Independence has a limited success. |
| U.S. consumption of petroleum grows to more than 20 million barrels per day. | (c) In any case— Steady expansion of coal production and infrastructure. Huge expansion of nuclear and coal powerplants. Pilot program for 10 to 20 \$1 billion plants for conversion of coal to gas and liquid fuel. Program itself may or may not be completed, but is "scheduled"—as is also a later phase in which 20 to 50 full-sized 50 to 100,000 barrels per day plants may be built before 1990. |
| U.S. oil industry is the recipient of hostile governmental "reforms" which cripple its ability to expand rapidly. | U.S. consumption stays below 20 million barrels per day. |
| 3. U.S. and world capital shortage (associated with 5 to 10 percent inflation everywhere). | Only moderate and acceptable reforms in oil industry. |
| | 3. Adequate supplies of capital here and abroad (as inflation recedes and savings and investment are encouraged). |

TABLE 1.—Two 1975 Economic-Social Scenarios for 1975-85—Continued

| EXTRAPOLATION OF MANY 1975 EXPECTATIONS AND DISCUSSIONS | HUDSON PREFERRED SCENARIO |
|--|---|
| <p>4. World living standards increase very slowly:</p> <p>Food prices keep rising—famine and starvation threaten or become reality.</p> <p>Raw materials prices keep rising.</p> <p>Fear of nationalism prevents many investments in Third World.</p> <p>Increasing number of cartel-like arrangements and acts of extreme economic nationalism disrupt orderly trade.</p> | <p>4. World living standards steadily increase:</p> <p>Food prices stabilize or decline.</p> <p>Raw materials prices decline.</p> <p>Developed world and OPEC invest heavily in third and fourth worlds, and in themselves.</p> |
| <p>5. Social, political, and cultural erosion in the U.S. (continuation of such events as Agnew scandal, Watergate, assassination attempts, exposure of corrupt business practices; resultant further decline of public confidence in U.S. institutions).</p> | <p>5. Things calm down (normal cyclical phenomenon)—fewer confrontations, shift of attention away from disturbing events. Ideological renewal government in United States.</p> |
| <p>6. Continuing rejection of traditional U.S. ideology and values (limits to growth ethic and attitude replaces work orientation, advancement orientation, achievement orientation ethic and attitude; science, technology, and affluence recede as important values).</p> | <p>6. Conscious counterreformation reinforces point 5 above and encourages some return to traditional values, some synthesis with the new values.</p> |
| <p>7. Growing (economically) counterproductive governmental interference; increased redtape; punitive measures against business.</p> | <p>7. Decrease and even elimination of many Government regulatory activities; rationalization and reform of others. Dividends are paid out of pretax receipt.</p> |
| <p>8. Development of two separate societies—white and black in the United States. Many cities are taken over by blacks, white flight to suburbs accelerates. Fiscal mismanagement and tactics of confrontation and blackmail produce a financial disaster in municipalities, revenue sharing encourages a business as usual attitude toward all the above.</p> | <p>8. Elimination of forced long-distance school busing; growing Negro emigration to suburbs; some white return to cities; central city schools improve; encouragement of voluntary busing—produced less tense atmosphere and more racially integrated society; integration is incomplete but acceptable.</p> |
| <p>9. Disastrous collapse of free world positions in Mediterranean, Southeast Asia, and much of Africa. Castro gains new prestige and energy out of Angola adventure. Insecure countries everywhere rush to make a deal with one Communist group or another.</p> | <p>9. Such losses are very limited. Indeed general growth of the world implies a relative weakening of both the United States and the U.S.S.R. and a strengthening of multipolarity.</p> |

B. THE CURRENT PESSIMISM, SENSE OF ILLEGITIMACY, AND GENERAL ANXIETY AND MALAISE

An extraordinary atmosphere of doom and gloom has dominated many current and recent discussions of U.S. and world economic pros-

pects. This tendency was particularly strong in 1974 and 1975; to a great extent, it still continues today. Perhaps the most influential single contributor to this pessimism were some of the various "limits to growth" and "finite earth" concepts. Their influence was not fully appreciated because these theories were accepted so readily and completely by so many as obvious truths (which simply described reality rather than containing some extraordinarily negative and pessimistic assumptions and prognoses). At the same time, many professionals—particularly economists and some senior governmental officials—rejected them so firmly that they did not realize how pervasive and important their influence was in the general intellectual and ideological milieu—particularly among many in the New Class.

I am not referring here to concepts based on the idea that certain sociological, cultural, and value trends could cause growth to be limited eventually (a concept we accept ourselves), but instead to the idea that mankind is running into a brick wall because of basic and unalterable physical limitations on energy and other resources, similar limitations on technology and available space for controlling or getting rid of pollution, and, finally, equally basic (if unspecified) limitations on man's ability to manage change and complexity. The addition of the fixed pie concept implies that there is also a basic illegitimacy and immorality to any society which blithely uses up the world's non-renewable resources in luxurious and wasteful activities to the great detriment of the poor today and of future generations.

A Harris Poll conducted in 1975 found that a 61–23 majority of the American people felt that it was morally wrong for this country, with 6 percent of the world's population, to consume 40 percent of the world's output of energy and raw materials. Fully 90 percent agreed that "we here in this country will have to find ways to cut back on the amount of things we consume and waste." Almost two-thirds of the public anticipated a consequent reduction in living standards.

It is often thought that the above results, at least in part, from guilt feeling by many Americans. This is probably true, but the guilt itself derives from the acceptance of a fixed pie concept. Thus, ten years ago most Americans were proud of the fact that they had about one-sixteenth of the world's population and used up about one-third of the world's raw materials. This showed their high state of development. Today many feel that this use of raw materials must hurt the poor, or at least appear to hurt the poor, and therefore is—or seems—immoral and probably, in fact, will not be allowed to continue for very much longer. These new attitudes came out of the "limits-to-growth" movement and now, rather paradoxically, support the movement, even when the original reasoning has been shown to be false.

The influence of this perspective probably peaked in early 1976. This "movement" now seems to be in retreat, led by some prominent members of the well-known Club of Rome who were among the first to urge a drastic slowing down of growth. Our own book³ seems to be having a major impact in the U.S. and abroad. Very recently (see *The New York Times* of October 14, 1976) a U.N. study group on "The Future of the World Economy" led by Wassily Leontief also argued that physical limits to growth, pollution control, and the man-

³ Herman Kahn, William Brown and Leon Martel, "The Next 200 Years: A Scenario for America and the World" (New York: William Morrow & Co., Inc., 1976).

agement of change would not raise any insurmountable problems—at least not in the long run.

One reason for the rapid and pervasive spread of the “limits to growth” perspective was that so many special interests and social groups really wanted to believe it, especially what we have called the New Class in the Atlantic Protestant countries (United States, Scandinavia, England, Holland, Canada, and Australia) and in Japan; they were attracted to the “limits to growth” position by reasons of self interest, guilt, and ideology, as well as the persuasiveness of the argument. Many people accepted these findings who normally are skeptical or even hostile toward controversial and elaborate computer studies—indeed many of these had been wont to use the term GIGO^{3a} freely.

At about the same time that this “limits to growth” view was becoming widespread, various specific problems arose from the oil embargo, the commodity boom, the environmental movement, the inflation, and the recession. To many observers, these problems seemingly demonstrated that there was indeed a disastrous lack of resources and living space, or an even more disastrous and uncontrolled pollution and a humanly unmanageable complexity. It was terribly easy to believe that all these problems were natural and inevitable, and were precursors of the doom and/or enforced austerity which were expected soon to be the common lot of mankind. On the other hand, the “limits to growth” perspective created a receptivity for any kind of doom and gloom thinkers. As a result, a vicious circle of reinforcement and amplification was created. Set in this context, almost all discussion of the likely future became extraordinarily pessimistic.

We list below some 25 possibilities that dominated much thinking about what seemed likely to happen in 1975 and 1976. Although almost none of these worries were totally groundless, I certainly do not believe that more than a fourth of them should have been taken seriously, and almost none of them as seriously as they were taken.

1. A catastrophic credit crunch in U.S. and/or world financial markets.
2. A truly runaway inflation or even a return to two-digit inflation.
3. A collapse of the Euro-dollar market.
4. Financial or economic collapse of Italy, the United Kingdom, or the bankruptcy of another really big U.S. company or bank (i.e., in addition to W. T. Grant and the Franklin Bank) or a big foreign company or bank.
5. Domestic orders and/or overwhelming political pressures (in almost any country) for inflationary policies because of inadequate programs against unemployment and recession.
6. Crippling of world economy because of a renewed oil embargo (touched off by a U.S. or Israeli-Arab confrontation) or further dramatic increase in energy prices with oil going to \$15-20 a barrel (in 1974 dollars).
7. Total inability of the world financial system to handle the recycling of OPEC dollars acceptably.
8. Collapse of current recovery because of insufficient stimulation of demand.

^{3a} At the time, this term stood for Garbage In, Garbage Out. It is now often taken to stand for Garbage In, Gospel Out.

9. Formation of many successful cartels in addition to those in fertilizers and oil (there is, in fact, almost a breakdown of the recent fertilizer "cartel").

10. Confirmation in the Club of Rome thesis that the world is running out of resources and pollution space.

11. Emergence of communist-dominated governments in Italy, Portugal, Spain, and perhaps elsewhere.

12. A precipitate withdrawal of the United States from Asia—or just from Taiwan and/or Korea.

13. As a result of the recent communist takeover in Indo-China, a political, economic, or military collapse of any ASEAN nation, or at least Thailand and Malaysia undergoing great political pressure and a great increase in subversive activities.

14. The creation of a real (and disastrous) "new international economic order" (as opposed to a "changing international order") or a dramatic and disruptive confrontation between the first and third worlds.

15. An outburst of "beggar thy neighbor" export and monetary policies.

16. A collapse of world trade for one reason or another (perhaps because of floating exchange rates).

17. An outbreak of a new Mid-East war.

18. Disastrous financial collapse of New York City.

19. Collapse of U.S. municipal bond market brought about for reasons other than a New York City collapse.

20. A collapse of the Third World because of balance of payments problems (about 40 billion dollars of new and renewed loans were made to the Third World in 1975—about half private and about half from international organizations and governments).

21. Serious communist pressures against (or takeover of) Taiwan or South Korea—or a serious slowdown in their economic growth because of lack of confidence in their future (or other pressures).

22. Major starvation in some large area (millions dying) followed by international political disorder—or at least very strong feelings of guilt and a backlash against the current system.

23. A continuation of various "food anomalies" of 1973 and 1974 (i.e. continued disappearance of Peruvian anchovies, drought in India and Soviet Union, etc.).

24. An end to increases in industrial and agricultural productivity in the U.S.

25. Massive Communist pressure on Western Europe, Middle East, or Indian Ocean.

None of these disasters predicted for 1975 and 1976 have actually occurred. And most (perhaps all) do not seem likely to materialize in the near future, though there are scenarios which could make some of them quite possible.

For the sake of balance we list also 10 desirable events which did *not* happen, but either should have happened or would have been very helpful if they had happened:

1. Serious energy programs by the U.S. and/or International Energy Agency.

2. Settlement, even temporarily, or one or more of the many Middle East confrontations (but there is a precarious status quo

between Egypt and Israel and the events in Lebanon make unlikely a serious Arab/Israeli confrontation in the near future).

3. Emergence of any really recognizable and generally accepted exciting domestic or international leadership anywhere in the West.

4. A persuasive answer to the Club of Rome or to the syndrome it represents and exploits (but perhaps *The Next 200 Years*⁴ will do the trick!) In any case there has been both a "backing down" and "topping out" of the "Limits to Growth" movement but it still has a most pervasive influence on thinking and acting of the New Class and many others.

5. A breakup of OPEC (though there has clearly been some strain, serious market pressures, and a sobering of expectations and rhetoric).

6. A reinvigorated EEC, NATO, or other western grouping.

7. A useful SALT II treaty.

8. Other effective moves (actual or potential) toward control of arms, terrorism, or other excessive use of violence.

9. Adequate recovery in Japan.

10. A serious owning up to responsibilities by Mayor Beame, Governor Carey, the New York Times, or other relevant spokesmen on New York City's financial problem. (But progress seems to be being made in reforming New York City's finances and even more in other local governments, i.e., New York City's plight *was* a good lesson.)

While their failure to happen tended to confirm a general feeling that leadership and competence are lacking, their non-occurrence was not disastrous.

In this atmosphere of an almost manic pessimism in many quarters, any reasonable perspective or observation often appeared at least to the pessimists to be either blind optimism or a feeble and ineffective effort at traditional boosterism—i.e., an ignorant or despairing effort to counteract the doom-and-gloom atmosphere in order to restore confidence and morale because confidence and morale are good things in their own right—an effort more akin to public relations and paid propaganda than to honest objective analysis and scholarship or informed judgment. Thus, many who accepted the general "limits to growth" perspective simply could not believe that reasonable and competent people could honestly disagree.

Further, this belief in the illegitimacy, immorality, and incompetency of the system and the need for reform or even revolution created a sense of ancien regime morale which legitimized and encouraged all kinds of passive or active obstructionism—and occasionally active sabotage by well meaning but ideologically motivated individuals in and out of governments. These people often regarded attempts to make the system work better as being immoral and contemptible, and even more so for attempts to justify the system. In many places, the atmosphere was more conducive to facilitate drop-outs, obstructionism, and despair than sober, cooperative and constructive activities.

C. SOME COMMENTS ON INFLATION

Let us turn to what is likely to be the central issue both now and for the next few years: inflation and, to some degree, a lingering stag-

⁴ Ibid.

flation. I do not believe that continued inflation is anywhere near as inevitable as most commentators and members of the financial and planning communities seem to believe. Thus almost every long-range planning study I have seen in the last two years that attempted to look 10 to 15 years ahead has assumed an almost automatic annual inflation rate of five percent or more. They also usually assumed that construction costs would be rising at about twice the assumed inflation rate. I believe that both of these assumptions are most improbable. I am not saying one could not live with a five percent inflation if it were stable, if the accounting were done properly, and if all kinds of indexed financial instruments and indexed contracts were made available; but this would be like making a double somersault in order to stand up straight. It may be necessary (at least for a time) to have indexed financial instruments and contracts in order to facilitate the transition to slow or zero inflation and to provide a hedge against the reemergence of inflation. (Probably the strongest reason for some additional indexation today is that it can be used to reduce the possibility of further inflation and facilitate the suppression of the current inflation with a relatively soft landing.)

It is very important to understand that indexing may be essential to the operation of the economy if one cannot accurately predict the future rate of inflation. Many economic ills which really arise from this problem are often mistakenly blamed on other factors. For example, assume that the law forbade the indexing of raw material prices. If so, it would be almost impossible to close a long-range contract between a producer and a buyer. The producer would have to assume a 10 percent inflation rate and build that into the contract price; otherwise he would feel unprotected. But the buyer would almost certainly be unwilling to accept more than five percent, if that much. Under these circumstances the raw material market would collapse. Although the collapse would doubtless be ascribed to all sorts of other things, the overriding reason would really be the outlawing of indexing.

Similarly for long-term contracts in the labor market. If indexing or cost of living increases were not permitted, the union would again have to assume ten percent inflation, the employer couldn't afford to go more than five, and one couldn't write contracts. Incredible labor problems would result, which once again would be ascribed to multiple causes.

Actually, wherever possible, businessmen and special interests have "invented" indexing. One could argue that something like two-thirds of the U.S. economy is indexed in one way or another, e.g. pension schemes, social security, welfare, financial instruments whose interest is tied to some prior rate, cost of living contracts, and so on. But this has been done haphazardly. Further, in many areas where it has been possible to use indexing, or where it has not been "invented," the economy is often in trouble. This shows up today, most dramatically, in the lags in housing and capital investment.

Currently mortgage rates of 8 or 9 percent are considered a very high price indeed. But if one believes that inflation will be 5 or 6 percent, one can argue that these 8 or 9 percent mortgage rates are nominal and that the real interest rates are more like 3 to 5 percent. In this same perspective, short-term money can now be obtained for less than

6 percent—a rate that is about equal to the expected inflation. So rather than talking about a capital shortage, we should be talking about capital availability. Real interest rates are at a very low level. However, under current tax policies and accounting principles, having such a difference in real and nominal interest rates not only makes capital look expensive; it subjects both borrowers and lenders to real burdens which discourage both of them, for both economic and psychological reasons.

We would argue that if there were no inflation and no expectation of inflation, there literally would be millions of families willing to borrow at greater than 4 percent real interest and millions of loans available at less than 4 percent real interest; therefore, there would be many housing starts in which the mortgage was 4 percent or so. However, today when somebody lends at 9 percent, he not only perceives himself as probably getting less than 4 percent but also of running a great risk of having his equity wiped out if the inflation increases to 10 percent or so. Furthermore, he has to pay income taxes on the full 9 percent. All this is extraordinarily discouraging to lenders.

The borrower may also perceive himself as paying 9 percent. If it is a business proposition, he certainly has to carry the 9 percent on his books as an expense. If he actually believes in the inflation, he thinks of his property as getting more valuable by about 5 or 6 percent a year or even more, and considers this increased equity as something to be weighed against his payment. In effect, 5 or 6 percent of the nominal 9 percent interest represents increased equity, and therefore is really repayment on the principal (which however is now more rapid than intended). Furthermore, he is not paying any taxes on this increased equity and can deduct the 9 percent nominal interest as a full expense. This is a subsidy to the borrower, but it is a subsidy which rarely outweighs the negative aspect of, in effect, too rapid repayment on the principle and the need to carry the 9 percent on the books as a real expense.

This is a “mono-cause” theory on the lack of housing starts and, like all mono-cause theories should be suspect. However, we are not saying that there are not many other things affecting the situation. We are saying that this is a sufficient reason for the problem and that, until this is faced, we do not expect housing to recover anywhere near as much as it could and should.

We also expect a slowdown, if a continuing pressure of prices is maintained, in the recent rapid increase in housing costs. In part, this should occur because of increasing difficulties which union labor is having in maintaining their share of the housing market and, in part, because there is a good chance that the growth in taxes, which is such a large part of the cost of owning a home today, will also be slowed down.

It should be noted that price controls are not likely to be very effective, in part because businessmen are now very conscious of the possibilities of price and wage control and many of them are now operating in such a way as to protect themselves from future price control. This causes some problems which are touched upon below.

First, a serious attempt is made to keep list prices high often while giving price concessions, in either a disguised form (such as the rebates given by the automobile companies in 1975) or are just hidden

by mislabeling, special treatment, special concessions, or other ruse. During several short periods in the last two years, our economy operated in a manner rather close to that of a Turkish bazaar. Purchasing agents were calling over the country, trying to get the best discounts they could. Such discounts did not show up in official prices or in price indices. Further, many businesses would rather lose their share of the market temporarily than find themselves frozen into prices which they consider too low. Indeed, many are also willing to over hire and even over pay temporarily because they fear that in the long run restrictions caused by wage or salary controls could be even more damaging by inducing a high turnover in employees and other difficulties. Thus the mere prospect of price controls can be very damaging in terms of current operations.

Jawboning can also be counterproductive. American labor has accepted quite reasonable settlements in 1975-76. Nevertheless, if the President asked working people to accept more than their fair share of the sacrifices which the community must bear in order to cope with inflation, most labor union people would be very hostile to any union leader who publicly went along with such an appeal. Rather paradoxically, much better behavior results from depending upon the innate common sense and feeling of responsibility of labor leaders and many of their followers instead of publicly appealing to them for special sacrifices. In this sense, jawboning can do more harm than good.

But let me return to the main point: Why I believe that inflation can be controlled. First and foremost, I think that in many countries, particularly the U.S., a steady inflation is very difficult to live with. Either it will escalate and then collapse or it will be forced down to lower levels. While most of the analysts whom I respect tend to predict the former, my personal guess is that the latter is not unlikely to occur. If one looks at the policies now being followed by the United States, Japan, and West Germany, they can be more or less characterized by the phrases "relatively tight money," "relatively tight fiscal policy," "relatively high unemployment policy," and "relatively low utilization of capacity policy." If these policies are continued over the next 3-5 years, as is certainly currently envisioned by the current administration in the U.S., Japan, and West Germany, then it seems to me that, even given all the rigidities of a modern economy, these three countries ought to be able to squeeze most or all of the inflation out of the system. It also turns out that these three countries together produce more than half of the gross product of the market-oriented economies of the world. In fact, together they produce about 40 percent of the gross world product. If just these three countries succeed in controlling their inflation, a world environment would very probably be created in which other countries could also control inflation. (Presumably, this world environment would have to include some restraints—self-imposed or not—on the "creation of money" by the Eurodollar banks and other such organizations.)

In order to get a perspective on our current problems, it is terribly important to understand the extent to which they are due to structural issues within the society or to broad general economic trends. I have tried to make the point here that, in the current circumstances in which there is, if anything an over anticipation of inflation and of

inflationary momentum, the most important issue is living with or suppressing inflation and creating confidence that this can be done.

Until we learn how to do this, it is not likely that there will be very satisfactory economic performance.

When inflation is greater than anticipated, a *de facto* transfer of income occurs to businessmen and to government. Under these conditions, the society can perform relatively easily, so long as those whose income is being taken don't get too angry or disruptive.

In a society where inflation is being overanticipated (as is true today), governments and business tend to lose, and the reaction when significant inflation does occur tends to be very disruptive. Some countries have learned to live with a continuing and erratic inflation but not those in which most businesses keep one set of relatively open and objective books and there is an "arms length" relationship between government and business. For more discussion of these issues, see Annex I.

D. EXPECTATIONS, MORALE, AND SELF-FULFILLING AND SELF-DEFEATING PROPHECIES

It is terribly important that confidence be restored to both consumers and businessmen. A modern economy depends upon confidence to a degree which is not adequately recognized. For example, since almost every consumer has a closet full of clothing, he really would not have to buy any more for a number of years if he was willing to repair old clothes and "make do" with what he had. Similarly, the average consumer does not have to buy furniture or a new house; he can repair the old and double up. He does not have to buy a new car; he can repair the old one. And so on down the line. All anyone really has to buy, in the short run is energy, food, and some other maintenance and operating items, upon all of which one can economize. If really frightened, most consumers could economize to the extent of about fifty percent of their purchases and not suffer great hardships, or even without seriously changing their standard of living (this is shown very dramatically in wartime when something like this often happens).

Similar remarks can be made about capital spending. When the question of investing in new plant and equipment comes up today, almost any corporate finance committee says something like the following: the future is very uncertain, the calculations are dubious (particularly because they have to count the high nominal interest rate as a genuine cost), and really, for the time being, we would be better off to patch up existing capacity to increase its output rather than making expensive, long term, irreversible commitments for new plants; so why don't we just do that and wait a year and then recheck the situation? This willingness and ability to defer such decisions for a year or more can play hell with capital expansion. I would argue that the expansion we all hope for will be seriously delayed unless something is done which will help businessmen reach more favorable and reliable calculations than can be done under current conditions.

It is clear that many people have been a little spoiled in their view of what is normal; this in turn affects their expectations and morale. Thus almost everyone now takes the post-World War II economic performance for granted. Nevertheless, this performance was most

extraordinary, and it clearly cannot simply continue for decade after decade. Between 1950 and 1973 Gross World Product (GWP) increased by about a factor of 3, Gross World Product per Capita (GWP/C) by a factor of about 2, and world population by a factor of about 1.5. During this period many economists believed that they had learned how to operate a rapidly growing, dynamically changing economy in such a way as to avoid even moderate recessions. Although we at Hudson regard this possibility as illusory, we also think that recessions can be limited to moderate proportions, perhaps less than the recent one, which itself was not extraordinarily severe. I am dismayed by the frequent remark that the recent recession is the worst since the Great Depression. That is a little bit like describing a relatively mild tremor in San Francisco as the worst since the Great Fire of 1906: technically accurate though it is, the comparison gives rise to some extremely unreasonable images and expectations.

In my opinion, almost any serious U.S. recession in the first hundred and fifty years of our national existence caused greater trauma and proportionately greater suffering than the recent one. However, I also doubt the inevitability of the sort of recessions which occurred regularly before World War II, with all the accompanying human tragedy and other costs. At the same time, it is very important that there be both perceived and real "downside risks" in the system. Furthermore, occasional actual recessions, painful and costly as they may be, do perform important social and economic functions: first, to "teach lessons" on prudence and sound management; second, to facilitate the squeezing and elimination of marginal activities; third, to allow for adjustments in lagging sectors, a slowing down of excessive growth sectors, and liquidation of excessive inventory; fourth, to put pressures on increased costs, waste, and inflationary trends; and fifth, to provide a kind of pause and motivation for other necessary adjustments.

Both the knowledge of "downside risks" and the experience of actual recessions create forces and environments that facilitate the normal operation of the system, promote adjustments to changed conditions, and provide some useful breathing space and opportunities. Furthermore, recessions, particularly mild ones, are a lot less painful under modern conditions than they used to be, and thus should not raise the same moral and political issues that the old style did. Unfortunately, many in our current generation of political leaders and leading economists do not see this. They have been so traumatized and sensitized by the great depression that they are almost immune to current data and observation. Nevertheless, a well managed dynamic economy is likely to have mild and relatively frequent recessions as a matter of course—and the fact that various groups lose out in such a recession should not be thought of as a disastrous trend but, for most of them, as a temporary, if painful, phenomenon that will be more than wiped out by the basic steady progress.

A useful analogy can be made with conditions in a seismic area. Relatively frequent but moderate earthquakes tend to relieve geologic pressures and strains, greatly decreasing the likelihood of a really big earthquake. Furthermore, people in such an area are often reminded of

the problem and thereby encouraged to build better, move elsewhere, or otherwise adjust to the possibility of an earthquake. If the earthquakes are sufficiently frequent and not overly intense, then structures which have been deteriorating or are badly maintained are much more likely to suffer partial damage than be completely demolished. Such partial damage, painful as it is, is not as painful as total destruction, nor is it usually permanent or even unflexible. Indeed, after even a mild earthquake, many shortcomings become glaringly apparent and therefore are more likely to be fixed or modified. If, however moderate earthquakes do not occur relatively often, then the earthquake when it finally comes, tends to relieve all the stresses that have built up over a long period and be very destructive indeed, especially since neither structures nor people will be well prepared to endure even small shocks. Any attempt to operate the U.S. economy without even moderate occasional downs, as well as ups, is likely to face similar problems. Every year cannot be a "vintage year"; real economies and societies do not move smoothly from peak to peak without interruption.

It is also worth stressing again that the 5 percent annual average growth in gross world product that characterized the 1950-1973 period was indeed extraordinary. There can be little doubt that growth will be at a much lower pace in the long-range future; however, I would speculate that the decade from 1975 through 1985 will quite probably experience an even more rapid growth rate, say 6 percent or so, in gross world product. (This last point is slightly misleading since part of this high growth rate represents a return to use of capacity and labor that had been idled by the recession, i.e., it is a catchup phenomenon. But most of it is caused by the likely rapid growth of what we later call Middle Income Countries and the growth that their growth stimulates.)

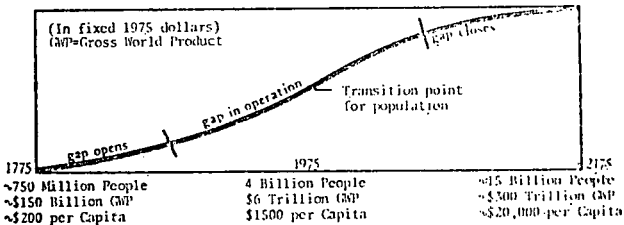
My basic reason for doubting that 5 percent annual growth in GWP can continue for any very lengthy period emerges from Hudson's studies of various countervailing social and cultural forces (discussed below). Another very good reason is that the resulting numbers stagger the imagination. Five percent annual growth means a doubling every 14 years; a factor of almost 12 in 50 years; a factor of 130 in a century; a factor of 17,000 in 200 years. Need more be said? There must be very few people indeed who, even without further thought and study, would not reject the idea that 200 years from now the Gross World Product will be some 15-20,000 times larger than today, i.e., about \$10 quadrillion in terms of 1975 dollars.

E. A REALISTIC IMAGE OF THE CURRENT WORLD-WIDE SITUATION AND FUTURE TRENDS

Two hundred years ago, almost everywhere human beings were comparatively few, poor, and at the mercy of the forces of nature; two centuries hence, barring some combination of very bad luck and/or very bad management, they should almost everywhere be numerous, rich, and in control of the forces of nature. This scenario is summarized in chart 1 which follows:

The Great Transition

AN OPTIMISTIC & PROGRESS ORIENTED (BUT REALISTIC) PERSPECTIVE
ON THE PAST, PRESENT, & FUTURE*



THE GAP OPENS (100 YEARS)

Pre 1775 All societies are pre-industrial, Income Ratio (ratio of richest 10% to poorest 10%) about 5 to 1
1775-1875 100 Years for initial industrialization of North Western Europe, Japan and North America, Income Ratio goes to 20 to 1

THE GAP IN OPERATION (150 YEARS)

1875-1950 Emergence of mass consumption societies in Europe, Japan and North America and start of worldwide industrialization
1950-1990 Four decades of rapid worldwide, economic and population growth; initial emergence of super-industrial economies, technological crises, and many historic transitions, e.g., inflection points in world population, and perhaps gross-product curves (also first steps into space)
1990-2025 Emergence of post-industrial economies* in most Western and some Neo-Sinic cultures** - perhaps also in U.S.S.R. Full development of super-industrial cultures* and societies* in advanced countries. First signs of a worldwide maturing economy. (First serious moves to colonize space), Income Ratio of 200 to 1

THE GAP CLOSES (100 YEARS?)

2025-2175 Worldwide slowing down in population and economic growth rates, (not only in percent but also in absolute numbers). As a result it takes almost 150 years for emergence of post-industrial economies almost everywhere. (Perhaps also the establishment of an independent solar society.) Income Ratio (on earth) 50 to 1 or less - perhaps much less
Post 2175 Post-industrial Society stabilizes, ossifies, or the next development in mankind emerges

* We distinguish between economy, institutions, culture and society as follows:

Economy: economic and technological activities

Institutions: laws and organizations

Culture: style, values, national character and attitudes

Society: the whole

Super-industrial Economy refers to large size and scale of modern enterprise and the importance of its impact on the external social and physical environment.

Post-Industrial Economy refers to a future very affluent economy which meets its industrial and materials needs with a small percent of its work force and economic effort

Presumably first the economy emerges, then the institutions, the culture, and then finally one has a harmonious society.

** Japan, Singapore, and perhaps Hong Kong, Taiwan, and South Korea.

CHART 1

I do not argue that this scenario is inevitable, but only that it is likely and plausible, given the data and trends which are known today. We have already mentioned that this flies in the face of much currently fashionable conventional wisdom, especially the view that even a brief continuation of recent trends of population growth and resource consumption, would lead inexorably to the collapse of modern civilization.

One key to this model of past and future history is that of a "Great Transition," expressed in the S-shaped (or logistical) curve depicted on the chart. After having been almost dormant for many millennia, growth rates for world population and gross world product began to

accelerate appreciably in the 18th century, and recently attained a pace which, if continued for a century or so, might indeed lead to overwhelming problems. I believe that both rates have peaked (or soon will) and we will now see a gradual leveling-off process, which will eventually stabilize at very high levels in the late 21st century. In my view, this slowing down will occur as the social consequence of free choices brought about by urbanization, changing priorities and values, and the proliferation of better standards of health, safety, literacy, affluence, and similar factors throughout the world. In brief, under current or similar conditions, as the average person becomes better off, he tends first to show less interest in having a large family and eventually in acquiring more material goods or income over his lifetime than his parents. (He may still be in the business of acquiring more material goods during his lifetime much as his father did.)

I do not, of course, suggest that progress will be smooth or automatic. On the contrary, mankind will certainly be plagued by many age-old problems for a long time to come, and will encounter many new ones along the way, some of which are unforeseeable today.

It should be emphasized once again that we also expect that under current trends growth in both the population and the economy will very likely flatten out at some point in the early twenty-first century for the United States, and perhaps a century or so later in those parts of the world which are just beginning their high growth rates. If we look at the four billion people in the world today, we note that they can be grouped into seven categories as shown in chart 2 below. About 30 percent of these people are poor by current and historic standards, but 70 percent are rich by historic standards. Of these 70 percent, 26 percent are rich by current standards, leaving 44 percent we could classify as neither affluent nor poor, i.e., middle income.

THERE WERE 4 BILLION PEOPLE IN 1975
DISTRIBUTED AS FOLLOWS*

| | | | | |
|------------------|---------------|---|-------------------------------------|---------------|
| POOR | (1165 OR 30%) | — | — DESPERATELY POOR | (215, \$100) |
| | | | — COPING POOR | (950, \$150) |
| MIDDLE INCOME | (1775 OR 44%) | — | — COMMUNIST ASIA | (925, \$340) |
| | | | — TRANSITIONAL | (500, \$500) |
| | | | — MOSTLY DEVELOPED | (350, \$1350) |
| AFFLUENT | (1060 OR 26%) | — | — COMMUNIST EUROPE | (385, \$3000) |
| | | | — CAPITALIST (INCLUDES OIL RICH) | (675, \$5400) |

*THE TWO NUMBERS IN PARENTHESES ARE MILLIONS OF PEOPLE IN THAT CATEGORY AND EITHER % OF WORLD POPULATION OR ESTIMATED GROSS PRODUCT PER CAPITA (IN 1975 DOLLARS).

If one wanted to know why the 30 percent are still poor, it is because they haven't become rich. This is not a frivolous remark. Economic growth, even in relatively homogenous countries, has often been uneven, hence even more so around the world. Those we classify as poor today are actually not very poor by traditional standards in which anything in the range \$100-\$300 per capita was considered more or less normal, i.e., about three-quarters of the poor are in this range which would be considered "normal" by traditional measurements or by traditional judgments.

We also believe that, under current circumstances, the income gap is the most constructive force ever devised for 1) creating a middle income group and 2) for moving them soon into a category of being rich. Further, after this middle income group has become rich, we believe most of the poor will also move quite rapidly to becoming rich. Indeed, with proper management, this movement might start among many of them in the immediate future.

One of the main reasons for wanting growth to continue is to maintain or even increase the gap, in order to maintain or increase the growth rate of the middle income and the poor. It should not be one of the primary objects of public policy to decrease the income gap but rather to make everybody rich, to make sure that within the next fifty years almost everybody has attained a level of over \$500 per capita (in 1975 dollars). Actually with good luck and reasonable management we might even reach \$1,000 per capita. There would still be a hard core poor group but this is inevitable. The point is that the hard core poor can probably easily be reduced to 5 to 10 percent of the world's population in fifty years, rather than the current 30 percent (and of course, we are leaving out here the many poor people who live in countries which we have labeled middle income and rich—but the lot of these can also be greatly improved with more growth). Absolute poverty is a much more disgraceful and deplorable situation than relative poverty. Reducing it therefore deserves the highest priority. And one of our most important objections to the no-growth society, is that it makes this reduction quite difficult.

Probably the most important comment one can make about the no-growth society is that by definition it is a fixed pie society. If there is a fixed population and a fixed gross national product, then when somebody goes up, somebody else has to go down; if somebody consumes more, somebody else has to consume less. This is almost certain to mean that it is not only stagnant in overall growth, but probably relatively stagnant in terms of the mobility of its members. To the extent that people do go up and down in such a society, they probably do so as a result of individual efforts rather than as a class, because any class movements would bring about extraordinary social conflicts. Furthermore, people who find themselves at the bottom of society will run into enormous difficulties if they want to improve themselves relative to their own past and current status. People at the very bottom end to be the least mobile part of our society; they tend to rise more as a result of trickle down from an increased pie than through their own unaided efforts. Once these people acquire skills, get started on their way, and become oriented toward work, advancement, and achievement, they can climb upward, but this is much more easily done in an expanding economy than in a stagnant one. A society which is stag-

nant at a very high level of consumption would be much more acceptable in terms of modern concepts of fairness than a society which is stagnant at a low level and in which people at the bottom really have serious problems in just getting along.

While we will not discuss it further here, I would like to assert that the problem of relative poverty—of inequality of income between nations that is so often addressed—is really more a problem of the “guilty” rich than of the poor. I do not believe that there are many businessmen, and even fewer peasants or workers, in Latin America, Africa, or Asia who would be willing to give up even a fraction of a percent increase of income and wealth in order to narrow the gap between the rich and the poor. This remark is not true of many of the governmental and intellectual leaders and even of some businessmen, but apparently it is true of an overwhelming majority of workers, peasants and, to almost the same extent, of businessmen. Let us, therefore, make our highest priority goal the ending of absolute poverty and not the ending of relative poverty. This might well be secondary and therefore a much lower priority goal. But it should probably never become a primary goal.

F. BUT WHY SHOULD THE GROWTH RATE CONTINUE DURING THE 1976-86 PERIOD AND THEN SLOW DOWN SO SOON?

The world growth situation is analogous to that of an adolescent boy. If one naively extrapolated (i.e., assumed a fixed exponential growth rate) the current growth rate of a 13 year old boy to the age of 25, he will turn out to be very big indeed. Some well-intentioned individuals might therefore argue, “Let’s stop him by starving him as close to death as is feasible. This will be terribly uncomfortable, and perhaps dangerous, but the alternative is worse.” But the fact is that his minimal nutritional needs are really quite high, and natural processes will slow down his growth. Perhaps the worst thing his self-appointed—or real—guardian can do at this point, is to persuade or force him to stop—or even slow down—his growth by putting him on an unnatural and harsh diet. He needs every bit of protein he can get. If one wanted to make him into a small man, it was really necessary to start with his heredity or his diet in early infancy and childhood. Thirteen is just the wrong time to do it—and it is also unnecessary. Furthermore, the child probably would like to be a relatively big man—and who can say he is wrong in holding these values (or the other set if he happens to hold them)?

What we are suggesting here is that the forces making for growth are at the moment so strong and have such great intrinsic momentum that despite all the roadblocks thrown in their way in the last decade or so, they are almost certainly going to triumph in the short run. We would argue that this is shown in part by the fact that both Presidential candidates represent part of what we call the counterreformation, a movement towards square values and away from the new values associated with the last decade.

My belief that the long-term rate of economic growth will drop off in the United States and worldwide is not based on fears of pollution or lack of energy or other resources. Under some circumstances these factors might eventually cause a slowdown, but it now seems much

more likely that long before these physical constraints set serious limits on either population or economic growth, social and cultural factors will intervene. The physical factors are almost irrelevant; though they could become critical at some point, the system simply does not seem likely to get very close to that point in any scenario that is plausible today.⁵ On the other hand, the cultural and social factors are, on the whole, more or less “natural” and probably inevitable. As a policy matter it can be asserted that most of them should be discouraged rather than encouraged in order to defer the timing and rate of turndown of the growth rate, but even this is arguable. In any case it is much easier overall and less traumatic to many groups to have this slow down deferred.

Perhaps the most important and basic of these social and cultural factors making for a slow down in economic growth is simply satiation—or at least a satisfaction of the most urgent needs and a corresponding change in priorities rather than a change in values, though this last is important too. These changing priorities are reflected in the size and composition of government budgets. Several recent studies point to the conclusion that the larger the public sector of an economy, the slower its real growth. The following chart 3 supports this view.

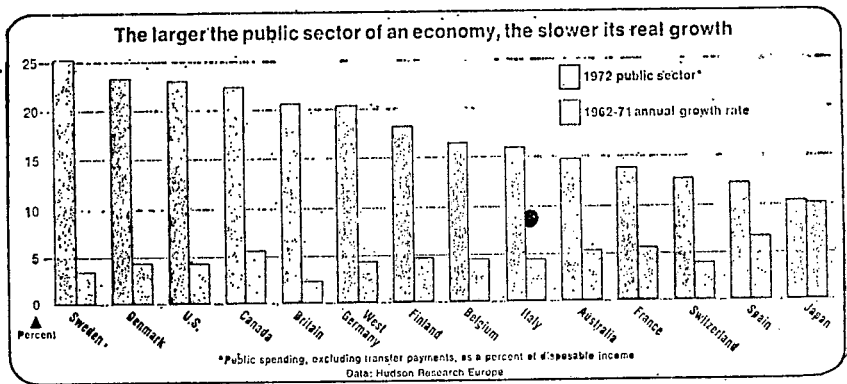


CHART 3

Although this finding is obviously controversial both in terms of the observed correlation and in terms of what is cause and what is effect, I am strongly inclined to think that the correlation exists and that it is enhanced by some seemingly obvious cause-effect relations.

As mentioned above, changes in values and attitudes are important, whether or not they are reflected in governmental budgets. People raised in a permissive, upper-middle-class suburban type of environment or similar environments have, on the one hand, been the recipient of ample benefits and, on the other, are simply no longer excited by economic growth and the opportunities it makes available. These people have not only always lived with the benefits of growth, they tend to take them more or less for granted and not see why other people so desperately desire them. In particular, they have a tendency to strike many balances on the pluses and minuses of our society in a peculiar way. Very conscious of the costs of economic growth, they often

⁵ See *The Next 200 Years*, Chapters II–VI for discussion.

ascribe all the evils and negative aspects of society to this one factor. As a result, the economic system is blamed for all the bad things it does do and for many it does not do, but gets little or no credit for the good it has already achieved and the bad it has prevented or alleviated (especially since this last is neither present nor visible). Naturally, this creates a very negative attitude among groups which think this way.

In addition, as people get richer, they naturally want to live better and more safely, which means that they will accept less environmental and ecological damage, less hassle, less bother, and less risk, while demanding more comfort and more leisure. In particular, thirteen trends or new emphases can be identified which seem particularly likely to play an increasing role in U.S. values, priorities, and attitudes, eventually (and perhaps prematurely) causing economic growth to slow :

1. Risk aversion.
2. Localism.
3. Comfort, safety, leisure and health.
4. Protection of environment and ecology.
5. Loss of nerve, will, optimism, confidence, and morale.
6. Public welfare and social justice (including equality of result).
7. Happiness and hedonism.
8. General anti-technology, anti-economic development, anti-middle class attitudes (e.g., "small is better" and "limits-to-growth" movements).
9. Many modern family values.
10. General de-emphasis of (or even hostility to) the thirteen traditional levers.
11. Increasing social control and "overall planning" of the economy of the "wrong kind."
12. Adversary regulatory attitudes.
13. Inner space (omphaloskepsis) and/or concern with self generally—also a turning to nonmaterial or even mystical and transcendental values.

A number of these "new" emphases and trends in the U.S. are not clearly new (hence we put the word in quotes), but now have a more intense and more pervasive effect, both in their own right and in competition with other values, attitudes, and goals. On the whole, these new emphases and trends are going to slow down economic growth and probably eventually cause it to be very low indeed or even become negative. It is, of course, impossible to estimate quantitatively the rate at which these trends will increase, and even more impossible to estimate the rate at which they will slow down economic growth, but we believe, quite strongly, that both these effects will occur and have some more or less intuitive judgments on the quantitative rates.

However, we also argue that, in many cases, a very extreme version of these emphases and trends has at least temporarily peaked during the last decade, and that a backlash or corrective phenomena will occur in the next decade, making them, for a while, less important than they have been in recent past. We expect this, not only because of these countervailing forces and corrections, but also because society will deal with measures to advance these values and with clashes with

other values more efficiently and smoothly and will therefore be able to live with them more satisfactorily, i.e., with less damage to other elements and trends. But we still believe that these forces will be more or less overwhelming in the long run (post-1986 period). We would also argue that in some sense, nothing would be wrong with this outcome (even if some would find nothing particularly right with it either).

It should be clear that some of these trends arise as a direct attempt to adapt to existing problems which have simply become more severe. Our whole concept of the superindustrial society emphasizes this point. However on the whole we do not worry more about the protection of environment and ecology because of the growing scale and destructiveness of the superindustrial society (though that is happening), but rather because standards are increasing rapidly. What was formerly acceptable, no longer is. It is this increase in standards, rather than an increase of stress, that raises the main issue and greatest costs.

The list is ordered roughly in terms of our judgment as to their current importance in slowing down economic growth during the decade to come. But we would argue that in the long run items 6 through 10 will probably be more important than 1 through 5. While the last three are potentially very important, they will probably be kept under reasonable control. Though No. 12 has been quite important in the last five years, we simply don't expect these adversary attitudes to continue.

Although Annex 2 discusses these emphases in detail, perhaps a few comments might be useful here.

Risk aversion means an attempt to reduce the risk associated with innovations and operations or to compensate people fully who have suffered damage. If this occurs, the associated economic costs can become unreasonably large. Furthermore, the desire to avoid errors of commission can become so great that errors of omission (i.e., errors caused by not doing things) become very costly.

Localism simply implies that conflicts very often arise between the national or regional good and the interests of a local area. Such conflict should sometimes be resolved in favor of the former, sometimes in favor of the latter. For a number of reasons, we expect local interests to become increasingly effective at the expense of the regional or national good. As this trend gets stronger, economic losses will grow. For example, there are no deep ports on the East coast of the United States, and no refineries have been built there for more than a decade. Although the region badly needs both, local opposition has blocked them. We need not explain why Nos. 3-6 can result in increasing economic inefficiency.

Rather surprisingly, many people don't realize that No. 7 can also conflict with economic growth, particularly if the concept is "happiness and hedonism" in the short run. The potential effects of No. 9 (many modern family values) are reasonably obvious; if these values got out of control, they could presumably stop economic growth, all by themselves—as they have in many preindustrial societies. Point No. 10 suggests that the traditional American national character, particularly in the form it took in the middle class, was extraordinarily favorable to economic growth (as is now true in many East Asian countries); that any great change in these traditional values can easily weaken a major source of economic growth.

The main point about social control and overall planning of the economy is that market forces are likely to be weakened while opportunities to gain control are increased for people who, for one reason or another, are either adverse to, or do not care much about, economic growth—or who just don't know what they are doing. Furthermore the term "planning" today is to some degree, a code word for a certain kind of planning and outlook which could easily be destructive to economic growth and technological advancement. Indeed more and often better planning, usually takes place in so-called unplanned systems which depend on market forces and decentralized decisionmaking than in these relatively naive, and unsophisticated attempts to apply complex mathematical models or precise optimization procedures to the overall economy.

Not only are most of the above emphases and trends going to be major reasons tending to cause a future slowdown in economic growth (in addition to a basic lack of motivation and need), but it would not be surprising if they did not, at least among some groups (i.e., the New Class) become overriding goals (much as the goal of economic growth has been in the recent past). Eventually we expect that the new values, attitudes, and goals will become quite widespread—even if modified—and largely replace the goal of economic growth. We expect this process to be largely suppressed and then re-emerge during the next decade, and to have gone quite far by the year 2000. Certain unfavorable demographic changes and other factors should also help cause a relatively rapid slowing down in economic growth by the end of the century to perhaps half the rate expected in the next decade.

All of this, to repeat, is more or less normal and to be expected. Nevertheless, very good arguments can be made at this time for slowing down the rate at which the slowdown occurs, and for moderating the excesses of the "safety fascists" and "eco-nuts" (to use two unfair, but increasingly common, expletives). We are not so rich or wise that we can afford to look only at the impact of these trends on growth. We should look also at their general economic impact, and examine and judge how they narrow and curb freedom of choice, inventiveness, creativity, and flexibility for both the individual and for various public and private institutions. Indeed, it would be almost disastrous from many perspectives—material, economic, political, moral, and ethical—to attempt too rapid a slowdown in the rate of growth because of an excessive emphasis on risk aversion, localism, increased safety, health, comfort, environment, and so on—desirable as these may be. This is particularly true if this "excessive emphasis" is manifested mainly by a relatively small, articulate, active, and influential minority—e.g. the "New Class". Furthermore, to a very large degree, hasty and badly thought out programs and policies pursuing these new goals have backfired, even in the short-run and even when measured by the criteria of those pursuing them. Good examples of this are provided by the decision to regulate gas prices, many aspects of the Nixon price and wage controls, many EPA programs, and so on—see Annex 2 for more discussion of this point.

In fact it is very easy to have excessive emphasis on these new trends and such an emphasis if continued is almost certain to have

disastrous effects by almost all criteria, even if it proves successful, as measured by some criteria, in the short run.

Much concern is of course expressed that the population explosion will overwhelm the system. In my view, however, the system is more likely to be characterized, as suggested earlier, by a "gross world product explosion" than by a population explosion. Furthermore, I expect this "gross world product explosion" to be one of the major factors, if not *the* major factor, in helping resolve the population explosion more or less satisfactorily. Other factors tending in this direction include changing values, distribution of birth control information and techniques, urbanization, declining need for child to provide economic and social security (and the decreasing effectiveness of children in doing this), declining economic value of children in contributing to family income and welfare or in providing discretionary income, and other changing priorities. This has occurred in part because of the greater cost of children, combined with their declining value (to put it in blunt terms, children have changed from being "producers" to being "consumers"). It should be noted that economic growth acts largely to limit population because it furthers almost all of the above tendencies.

ANNEX 1

THE CURRENT INFLATION IN PERSPECTIVE

Why Stagflation

Table 1 lists the factors which we feel have been important in causing the recent stagflation. It serves to show that the stagflation was a highly complex phenomenon, but not complex enough to be beyond comprehension. Any objective economist who studied the various relevant policies of the late '60s and early '70s and who had some reasonable sense of cause and effect might have been able to predict the stagflation. In fact Peter Drucker (in earlier works) and Milton Friedman (at the time) seem to have done so (and to a lesser extent Hudson in its January 1974 report to the Corporate Environment Program; and to an even lesser extent Galbraith in his concern for managed markets and union-distorted wages). Many, of course, (in the early '70s) predicted inflation and many predicted collapse, but few seem to have expected the two together—though it now seems obvious.

Another important reason for presenting this rather lengthy and complex list is to emphasize that the causes were multiple and interacted in a mutually-reinforcing manner. The result was an almost worldwide wave of two digit inflation. It is equally important to notice that as one or more of these causes vanish, is corrected or absorbed, very likely the force behind the continuing inflation decreases, perhaps more than one would have thought, since these "old" forces reinforced each other. In particular we would argue that the reader who studies the causes carefully will note that very few of them are likely to remain or recur in the next five years or so, assuming of course that at least the U.S. and the Japanese retain their current policies. However similar events and attitudes could recur in the longer run future when the "lessons" learned and policies adopted because of the current recession have eroded. And, of course, current (self-fulfilling) momentum and expectations of inflation continue.

TABLE 1.—*More or less accidental factors contributing to current stagflation*

1. Excess creation of money and bad management of subsequent inflation:
 - A. U.S. financial policies from 1969 to 1973 which increased U.S. dollar supply directly and also sent an unwanted \$60 billion overseas (with corresponding increases in world liquidity).
 - B. Growth of an uncontrolled Euro-dollar market.
 - C. "Dumping" of U.S. dollars in 1972 and 1973 by the Japanese.
 - D. "Runaway" speculation and speculative practices by many banks and businesses.

- E. Decline of real working capital available to non-financial firms in U.S. and U.K. because of taxation and dividends paid out of illusory inventory profits and understated depreciation allowances.
- F. Fixed exchange rates acted as an engine of money creation.
- 2. Pressure on capacity and resources:
 - A. Rate of growth in gross world product from mid/late 1972 to mid/late 1973 about 40 percent above normal (almost all countries in phase with each other).
 - B. But increasing difficulties of investment in and other expansion of capacity—particularly of raw materials.
 - 1. Many aspects of the environmental movement.
 - 2. Such irrational policies as U.S. keeping the price of natural gas very low.
 - 3. Special issues of Alaska and Alaska pipeline and the North Slope.
 - 4. "Limits to Growth" propaganda caused worldwide lack of confidence and strengthened "localism" and other opposition to growth.
 - 5. Other sources of hostility to growth—particularly among upper middle class elites and intellectuals in Japan and the Atlantic Protestant culture.
 - 6. Surge of nationalism with regard to raw materials in Canada, Australia, and Third World.
- 3. Various pressures on food prices in 1973 including:
 - A. A withdrawal in 1972 by United States, Canada, and Australia of much land from food production in order to keep prices from dropping.
 - B. Bad weather in a number of places.
 - C. A temporary decline in the anchovy fishing of Peru.
 - D. A general shift to meat and a willingness by the Soviet Union to buy foreign grain to protect the Soviet version of this shift.
 - E. An inadequate expansion of fertilizer industry due to over expansion in mid/late sixties.
 - F. A decision by the Indian Government in 1969 to shift emphasis from food production to industrialization.
 - G. Relative short-term inelasticity of both supply and demand of food.
- 4. The energy crisis (which contained a number of accidental elements) and the relative (only food and energy have these characteristics) short-term inelasticity of both supply and demand of energy.⁶
- 5. Other contributions came from:
 - A. A general and almost congenital fear of depression, willingness to accept almost any anti-depression policies. A general and increasing distrust in fiat currencies, a general acceptance and *anticipation* of inflation, and almost no fear of a "downside" risk in investment and even speculation.
 - B. In the United States a combination of the Vietnamese war with great pressure to expand welfare and city programs—also the decade of social malaise and educated incapacity.
 - D. The existence of extremely weak governments almost everywhere.
 - E. A number of bad governmental decisions and unfortunate events.

Four Useful Points

Next, let us make four useful points even if only in passing. First, the inflation had been very substantial even before the rise in oil prices in late 1973 and early 1974. Table 2 shows that from 1950 to 1970 the currencies of OECD countries lost at least 40 percent of their value; in many countries the loss was almost 100 percent. Thus very big losses occurred even when the annual inflation rate was relatively low (but almost continuous over the 20-year period). Nevertheless, and this is my second point, inflation is not a normal condition. No long-term inflationary trend exists for Europe and North America, despite the current widespread belief that such a trend is a normal part of the system. Such a trend is apparent only since World War II. Actually there have only been two major long-term inflations in Western culture in the last 500 years. The first occurred in sixteenth century, when Spanish gold drove up prices more or less perma-

⁶This is in part because of the ability and willingness of public and private sources to finance the third world and the welfare state generally. As a result even the relatively poor can maintain most of their consumptions.

nently; the second took place after World War II. When people remark that the U.S. has had an inflation since 1895, they are making an extrapolation (the dotted line on the right in Figure 1) which ignores the drop in prices which occurred after World War I.

TABLE 2.—CHANGE IN THE VALUE OF MONEY 1960-70

| Country | 1970 value of money as of 1950 value | Annual rate of depreciation |
|---------------------|--------------------------------------|-----------------------------|
| Switzerland..... | 62 | 2.3 |
| West Germany..... | 61 | 2.4 |
| United States..... | 60 | 2.5 |
| Australia..... | 56 | 2.9 |
| Italy..... | 51 | 3.3 |
| Sweden..... | 48 | 3.6 |
| United Kingdom..... | 48 | 3.6 |
| Japan..... | 44 | 4.0 |
| Mexico..... | 42 | 4.2 |
| France..... | 41 | 4.4 |
| India..... | 40 | 4.5 |
| Israel..... | 39 | 5.1 |
| Spain..... | 35 | 5.1 |
| Yugoslavia..... | 20 | 7.7 |
| Vietnam..... | 14 | 9.4 |
| Chile..... | 7 | 12.5 |
| Brazil..... | 5 | 14.0 |

WHOLESALE PRICE LEVEL IN THE UNITED STATES
1950-1970

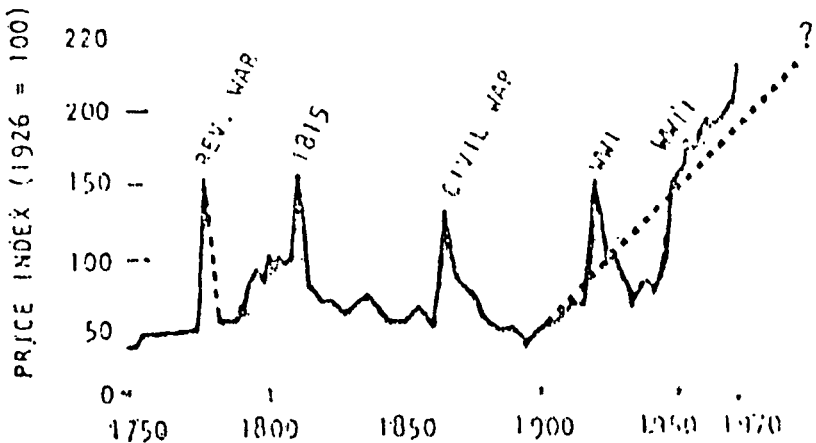
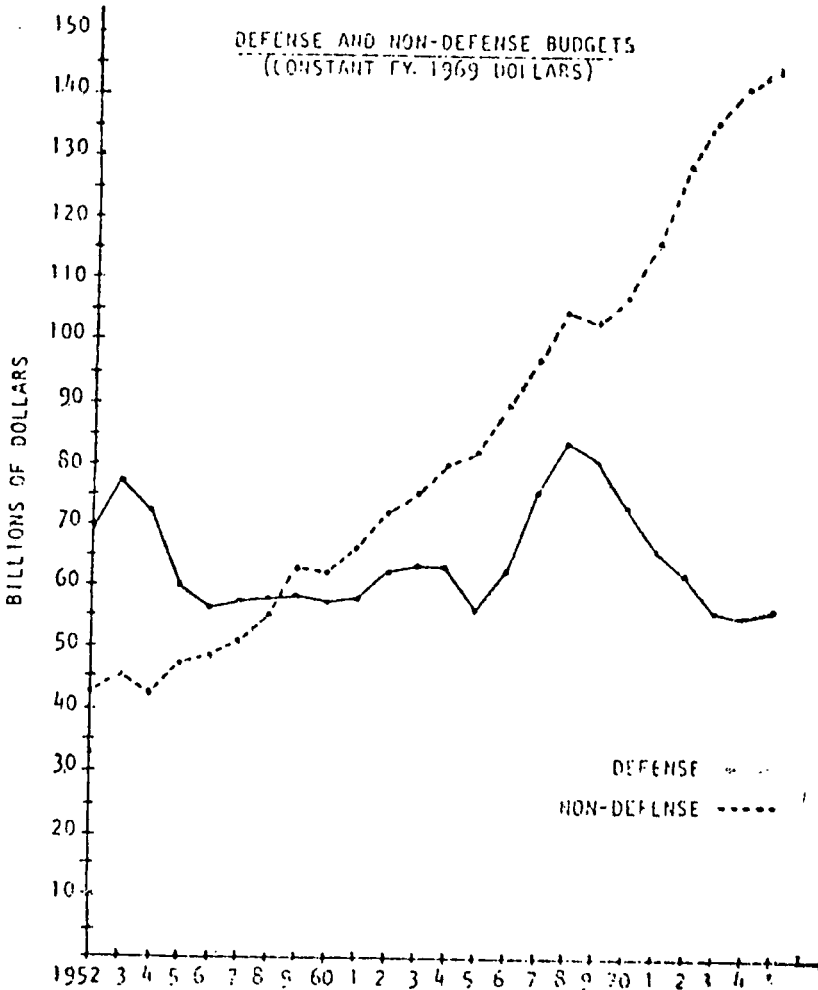


FIGURE 1

Since World War II (as a result of the Great Depression and the resulting intellectual, political, and psychological context), the system contains so many anti-deflationary safeguards that, on the one hand, it became almost incapable of exerting almost any effective pressure against prices, and on the other hand, the price and wage structure became so rigid that inflation could not in fact be effectively countered (without either first going into a catastrophic deflationary stage or by having continuous pressure over some years). Today it seems likely that the world might stay on a permanently higher price level but will not necessarily be permanently subject to continuous inflation (i.e. move onto an even higher price level). Indeed I have already asserted my belief that current U.S.-Japanese-West German policies, if continued for the next five years or so (a policy of relatively tight money, relatively tight credit, relatively high unused plant capacity, relatively responsible fiscal behavior, and relatively high unemployment), should result in controlling inflation in these two countries. Furthermore, I believe there is a good likelihood that the policies will be continued. Therefore, I do not share the view that the next decade or so is going to be

characterized by steady 5 to 6 percent inflation. In fact, I would argue that in a country like the United States, such inflation would result in a basically unstable situation, easily escalating and then creating a financial collapse, with subsequent deflation. Therefore, I would find a continuous 5 to 6 percent inflation over the next decade or so most improbable, even though almost every study, governmental or private, I have seen in the last two years which tries to predict the price level over the next decade makes such an assumption.

The third point is that the recent "runaway" inflation was well under way before the oil crisis. Thus, not only did the oil shock have very little to do with starting this inflation. I think that its continuing inflationary impact has been much exaggerated. This misapprehension results, to some extent, from an accident of the U.S. price index. It counts oil as a raw product, as part of intermediate products such as petrochemicals, and as part of the end products. Thus oil is counted three times. A change in the oil price therefore has a disproportionate impact on U.S. wholesale price index. But the reason is simply technical—an accidental quirk of the index.



*ADJUSTED BY APPROPRIATE PRICE DEFLATORS

SOURCE: OFFICE OF MANAGEMENT AND BUDGET

FIGURE 2

Finally, a minor point which is much misunderstood. The idea is widespread that our inflationary troubles are due almost solely to the Vietnam War military expenditures. Figure 2 tends to refute this concept. Thus, in terms of *increased spending*, the non-military budget was four times as large as the military budget. People who blame inflation solely on the military Vietnamese War often don't understand that programs which they often favored also contributed to the inflation. I have shown this Figure 2 to literally hundreds of people in this country. Although nobody challenges the numbers, as far as I can tell, I have not succeeded in affecting public discourse on the subject—even by most of those with whom I have discussed the point. It continues to be a form of conventional wisdom to assert that the Vietnamese War military expenditures caused the U.S. inflation. People who make this assertion seem oblivious of simple reality. Although every American economist who is interested in inflation must be aware of these facts, nevertheless the discussion of the causes of inflation in this country goes forward as if these facts were kept secret. None of this is to challenge the idea that the Vietnamese War contributed heavily to the inflation. Thus, to some extent during the Vietnamese War some Congressmen who were willing to support the war said, "if you vote for my war I'll vote for your city program." A sort of trade took place along these lines. And President Johnson himself specifically tried to carry on the Great Society program and the war simultaneously. But the fact remains that the main inflationary pressure in our economy during the past 15 years came from the increase in civilian expenditures rather than from the mounting military expenditures—even at the height of the Vietnamese War.

Unanticipated vs. Anticipated Inflation

I believe that a very significant and much underestimated change has taken place during the last four years both in the nature of inflation and in public attitudes toward inflation which has caused much confusion. The non-communist world has moved from what could be called a situation of largely "unanticipated" and "acceptable" inflation to one of largely "anticipated" and "unacceptable" inflation. Unanticipated inflation simply means that the real level of current inflation was larger than people generally expected (not that no inflation at all was expected). Anticipated inflation means that the current inflation is less than expected—or at least that people are trying to do something about the high level of inflation which they expected. They are correcting for the coming inflation, or trying to do so.

During an *unanticipated* inflation a large amount of income is transferred from creditors to debtors. About 2 trillion dollars worth of debt is said to exist in the United States. Since a substantial part of this amount is held by people who are also creditors, inflation is canceled out for them to some degree. However, it turns out that households, in general, are net creditors to the amount of about a trillion dollars through pensions, insurance holdings, cash, and ownership of deposits in banks and fixed obligations such as bonds. Almost every other segment of our society is a net debtor. As a result, if interest rates do not accurately reflect the rate of inflation, a huge transfer of resources occurs from households to government, business institutions, and so on. Thus, it seems plausible that an inflation rate of say three percent—which many would consider very acceptable—would result in the transfer of about 30 billion dollars a year by this mechanism alone, not a small sum of money. Also, if wages and governmental pensions lag behind the inflation, then employers receive a similar net gain. The largest single beneficiary from such gains is undoubtedly the government, at least under normal circumstances. The government gains from *unanticipated* inflation as follows:

TABLE 3

1. As a debtor and disburser of fixed payments (pensions, welfare, interest and principal on the national debt).
2. As a recipient of seigniorage profits—(can be considered as a debasement of currency or a tax on cash balances).
3. As a tax collector (brackets are moved upwards in real terms; understated depreciation allowances, and nominal inventory gains result in taxable if illusory profits).
4. As an employer.

5. As an advocate of full employment, high farm prices, etc.

6. As a permissive umpire and bargainer, i.e., as a supporter of satisfaction and contentment (e.g., can exploit money illusion) and a reluctant appeaser of squeaking wheels and strong or activist pressure groups.

Many other organizations, especially in business, also gain from an unanticipated inflation. It can plausibly be argued that these gains to both government and business have been the main reason that the inflation occurred.

When inflation is anticipated, however, many of these relationships are altered. First and foremost, wages, welfare, income from interest, and similar payments now tend to have excessive corrections for inflation. This occurs partly because the usual indices tend to overestimate the rate of inflation and partly because the affected groups wield very considerable economic and political power once they become aroused and militant. The Phillips Curve turns around, as do business expectations: that is, unemployment tends to go up if the future looks more inflationary than the present and even stock market prices tend to go down. Attempts to stimulate the economy are apt to backfire because they bring about expectations of increased inflation, and therefore decrease confidence in the future. In general, gainers and losers exchange places in an anticipated inflation, but now there are many more losers than gainers—and the losers are now militant and vocal. As a result of all these changes, inflation becomes politically more unpopular than unemployment. Political parties and leaders who are perceived to be more likely to control inflation than their opponents are therefore more likely to be elected. Governments which continue to focus their primary attention on the traditional problems of unemployment and deflation find that their programs and concerns fail to attract nearly as much approval as they expected. One reason for all that is of course that the unemployment today is far less unpleasant than it once was.

We do not want, however, to give the reader the impression that a condition of anticipated inflation is preferable to its counterpart; the opposite is more likely to be true. Thus, the cost of anticipating inflation and hedging against it can be extremely high in economic terms. In some cases, no effective means can be devised to put one's anticipation of inflation into action. One method of anticipating inflation is indexing. Indeed the operation of the U.S. economy is probably more than half indexed at the present time (i.e. wages, pensions, welfare, many loans, sale and purchase contracts, etc.). Since the index is normally tied to the cost of living in urban areas, it tends to overcompensate for inflation. It should be noted that indexing can be absolutely essential in some situations. For example, it is difficult to see how a long term contract could be signed for the production of a mine or the procurement of other raw materials unless the contract were indexed to the rate of inflation. In the absence of indexing, the seller would certainly insist on something like a 7-8 percent increase in price per year to protect against possible inflation; the buyer would probably be unwilling to accept more than 3 or 4 percent. If either party were to budge from his position, he would face the possibility of large losses (consider what happened to Westinghouse) and therefore it would be impossible to get such a contract signed. Fortunately, contracts can be readjusted every year to take account of the actual inflation rate (i.e., to index); this of course makes it possible to sign such contracts. A similar case could be made for long term (three to five year) labor contracts or even for the purchase of producer goods which generally involve contracts of from 6 months to 6 years. Furthermore, groups with political power, such as government employees, pensioners, and welfare recipients have all managed to have their payments indexed. This means that these people no longer lose from inflation—and may even gain—since the index chosen probably overestimates the impact of inflation on them. (It can be argued that social security payments are now doubly indexed, so that the real income of recipients now goes up about twice as fast as inflation.)

I believe that the main problem with capital accumulation in the United States today is that the financial system is not properly indexed. As a result, the borrower is forced to treat all of his interest rate as an expense when in fact some portion represents the early repayment of capital (most of that portion of the interest which is actually due to inflationary expectations). Even when nominal interest rates were as high as 12 percent for quality borrowers (in late '74 and early '75), inflation was also running at a rate about 12 percent. Since many people's inflationary expectations were very high, the "real" interest rate

was in fact very low. Thus, if borrowers are paying 8-9 percent on their money, but both lender and borrowers expect 5-6 percent inflation, then the real interest rate is only about 3 percent, which is not a high rate at all. But since the borrower does his accounting in such a way as to treat the 8-9 percent as a real cost, the cost of capital looks very high indeed. Furthermore, the lender must pay income tax on the inflationary (and therefore non-income) part of the interest. Effects such as these make us argue later on that a healthy recovery needs to have a limited and perhaps temporary indexing of instruments like mortgages and long-term bonds.

One of the most remarkable characteristics of the current inflation is the almost reckless manner in which some companies are willing to lock themselves into long term bonds with very high interest rates. Many companies seem to have forgotten that a downside risk in interest rates still exists; inflation might well be alleviated, and then anybody who has signed an uncallable loan for 10 or so percent will be paying perhaps two or three times that which should be paid. On the other hand, if the inflation stays between 5 and 10 percent, then such a loan may turn out to be a bargain since the assets it covers will increase in value (or not decrease as fast as the normal depreciation). Of course, the understated depreciation allowance may itself cause a problem.

Other Effects of the Current Inflation and the Lack of Inflation Correcting Accounting

This brings us to a most important current issue: the incredible degree to which nominal earnings by U.S. manufacturing corporations have depended upon illusionary inventory profits and understated depreciation. This is shown in Figure 3 below which compares nominal retained earnings and dividends with "real" retained earnings (earnings corrected for understated depreciation allowances and inventory profits—"income" which does not add to the usable cash flow of the organization but is taxed as if it were real profits). Seen from this perfectly reasonable perspective, U.S. non-financial corporations have, since about 1968, paid out as dividends on the average close to 100 percent of their real earnings. As a result, no net increase has occurred in the assets of these companies as a result of retained earnings, even though in many cases their nominal volume of business has increased enormously. This brings about excessive requirements for debt financing, especially for short term circulating debt, which is indeed a very precarious way to operate. This problem is one of the main reasons why the American firms were in such a sad state in 1975. In fact U.S. firms have improved their position enormously in this respect, but a year or two ago many were very close to being in critical condition. I consider it remarkable that more bankruptcies of the W. T. Grant's sort have not occurred.

Stickiness of Prices

As many economists have noted, big companies and big labor unions—working together, in effect—can prevent prices from dropping because of the large influence their wage settlements have on other sectors of the economy. While we agree that prices and wages are much less elastic on the downside than on the upside, we also feel that the stickiness is exaggerated—especially against long term continued pressure. In any case, fear of continued inflation adds to this tilt against a possible drop in wages and prices. For example a businessman's fear of being stuck with price controls some months ahead will lead to his emphasizing high list prices, concealing discounts, and giving up a share of the market on the assumption that the loss will be temporary and more acceptable than being locked by government fiat into a seemingly permanent lower price level. By the same token, individual businessmen in an industry would be taking an extraordinary risk to lower prices significantly, for fear that if the rest of the industry actually followed through with a general price decrease, the whole group might then be faced, after the imposition of price controls, with an unprofitable price level. A typical example of this phenomenon occurred in the auto industry.

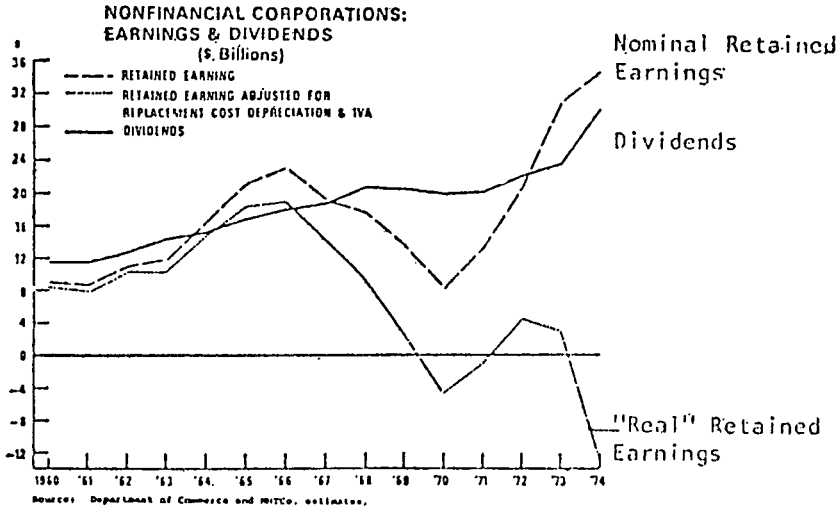


FIGURE 3

Chrysler wanted to cut prices in 1974, but did so only in the form of "rebates," meaning that it could keep its list prices exactly as planned, in the event price controls were clamped on. Other companies followed Chrysler's lead, but, again through rebates, not official price decreases. Finally, a continued excess in the money supply feeds other upward pressures on price.

Indexing as a Temporary Solution

Much interest is currently being devoted to indexing as a means of coping with inflation; sometimes it is even hailed as a cure-all. Indexing is certainly no panacea. Indeed it will work only under certain circumstances; thus, other government policies must facilitate and complement indexing and put it into its proper context. I have often argued that, in the absence of indexing, the government cannot solve the problem of inflation unless it displays courage, integrity, wisdom, common sense, and political power. The same qualities are also needed if indexing is employed, but the amount required is much smaller—and this difference is important. But indexing is not necessarily desirable. Table 4 shows at least five ways that inappropriate indexing can cause trouble.

TABLE 4.—*Inappropriate indexing can hurt—even cause a disaster*

1. Can try to compensate for the uncompensable.
2. Can destroy certain automatic compensatory measures that normally mitigate an inflation and add automatic compensatory measures that increase an inflation.
3. Can eliminate important lags, austerities, and political pressures.
4. Can destroy important utilities associated with the monetary illusion.
5. Can cause degree of inflation to be even more politically motivated and in effect create a new area for "bungling government interference" and for making the simple complex.

For this reason alone, I oppose indexing under normal circumstances. I certainly don't recommend indexing as permanent pervasive policy. Nevertheless, I strongly advocate an expansion of indexing in this country at the present time.

Let's look at some sample situations. Imagine (again I am talking about the United States, but believe the case to have universal application) that indexing were forbidden, that all contracts had to be written in fixed prices. What would happen? Well as we already suggested it would be impossible to sign a 20-year contract, say for mine production. Because obviously the producers are going to want to protect themselves against the possibility of a 5 to 10 percent inflation and the buyer is going to argue for 0-5 percent. Differences of this size would undermine the entire raw materials industry. After the industry had collapsed would people have understood why? Not necessarily. Many would cite twenty different reasons, only one of which was the inflation and the uncertainties it caused. In fact, this would have only been the real reason. But who would understand that? Thus a gimmick—in this case indexing—can make all the difference.

During this century all economic recoveries in this country have been led by housing or automobiles. Although I expect the current recovery to be sustained even though it was led instead by consumer goods purchasing (but automobile sales have now also revived), I would feel much more comfortable if the housing sector was much stronger than it is likely to be. Why aren't we likely to have a housing recovery? Because current mortgages cost 9 percent—at least nominally. Since the inflation is about 6 percent, the real rate is about 3 percent, which most buyers could afford. Actually, millions of people in the country are perfectly willing to pay a real interest rate of 5-6 percent to buy a house, and tens of thousands are willing to lend at a real 4-5 percent rate. Why can't they get together? Because indexed mortgages are not permitted here. Although other reasons can be found, this single circumstance accounts for the collapse and slow recovery of the housing industry.

But this is only part of the story. I have given many speeches before savings and loan associations since December of 1974. I open my speeches by saying: "Ninety-five percent of you work for organizations which are technically insolvent." What do I mean by technically insolvent? I mean that if one examined the market value of their assets (which include 5 percent mortgages made for 20 years) many of these assets discount today at 65, 70, or 80 percent. But the market worth of the liabilities (mostly deposits) is valued at 100 cents on the dollar. If one actually had to liquidate these organizations, he would find that they have a negative net worth. That is also true, I believe, for many savings and commercial banks in the United States (if they wrote off fully or carried at current market value, many of their loan and other investments—e.g., tankers, office buildings, REITS, municipal bonds, etc.) but I don't really know.

Instead of getting angry, as they should, my audience invariably reacts by indicating that "we're all in the same boat." Now that was a shaky situation! (Note, conditions have been much improved since December 1974 and January 1975.)

I ask these people in the savings and loan associations to assume that no inflation occurs for five years. Would they then be willing to make a 3½-4 percent government-guaranteed loan (which is roughly what the interest rate should be)? Textbooks say that a risk-free loan has earned empirically about 2½ percent; the actual record according to recent research is more like 1-1½ percent. The United States has historically had government-guaranteed mortgages of around 4 percent. I ask these people whether they would be willing once again to make a "risk-free" government-guaranteed loan of 3½-4 percent. They reply—absolutely not, because it is not risk free. If inflation recurs, they would lose their money. If inflation hits 8 percent, they would lose 4 percent annually, instead of earning 4 percent. The market value of the mortgage would go down and they would be insolvent once again. When I ask what minimum interest they would charge if no inflation happens for five years, they never say less than 7 percent. In other words, savings and loan associations would charge at least 3 percent as a hedge against inflation. This means that it is not possible to return easily to a situation where inflation is not anticipated. Indexing is the only way to avoid paying the exorbitant sum of 3 percent as an anti-inflationary hedge. As we explained in Hudson Corporate Environment Research Memorandum #9, the principal of the mortgage should be indexed rather than the payments in order to smooth out variations in payments.

It is my considered opinion that indexing (even if temporary) is one of several measures which could help to promote a satisfactory economic recovery in this country. It can do this by:

TABLE 5.—Indexing can: (If appropriately used)

1. Reduce or terminate expectations of inflation and restore faith and credibility in money and contracts.
2. Prevent inflationary gains to Government and others.
3. Increase flexibility of prices and wages and otherwise facilitate a soft landing from an ongoing inflation.
4. Serve ends of *relative* social justice and business stability.
5. Prevent disastrous "anti-inflationary reactions" to a near inflation by a population which has already been made "allergic" or at least educated.
6. Encourage savings and mobilize capital.
7. Can make accounting realistic and otherwise improve operation of economic system.
8. Be done gradually.

"Do-Nothing" or Doing-Too-Much?

Figure 4 dates from the early '75 briefings to the Savings and Loan Association and others. It deals with government policy, which will be discussed later in more detail. The Ford Administration is explicitly pursuing the policy shown.

A BASIC (BUT OPTIMISTIC) ECONOMIC SCENARIO
(BOTH GOOD STATESMANSHIP AND GOOD POLITICS)

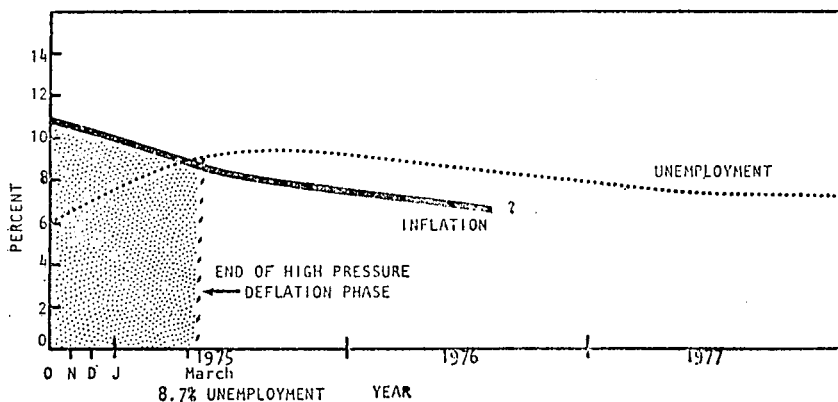


FIGURE 4

The present administration is pursuing a policy of tight money, tight credit, fiscal restraint, high unemployment, and high unused capacity and intends to do so for five years more. The official Japanese policy is the same. I don't fully believe all of the official Japanese policy in the following sense. They talk about an annual growth rate of 5 or 6 percent. In my view, a Japanese 9 percent growth rate would correspond to tight money, tight credit, reasonable fiscal policy, high unemployment (for Japan), and low capacity utilization. There is no *a priori*

reason to doubt that five years of such policies would bring inflation under control. I will discuss other measures which would make the control faster and more reliable. It is easy to find reasons for not pursuing such a policy in the United States. Some are listed below :

TABLE 6.—*Basic objections*

1. Requires patience,⁷ courage, and stoicism.
2. High probability of depression.⁸ (Somewhat lower than in 1975).
3. Much economic suffering: Unemployment, bankruptcies and other losses.
4. Exportation of deflation to other countries.
5. Not as well designed as it could be.⁹

The most important obstacle is that such policies require heroic—and scarce—qualities. They are very slow. If something goes wrong and a really serious depression results, nobody will think it was bad luck. President Ford would go down as the dumbest man in history: he took an entire country over a cliff with his eyes open. Remember now, this policy has been criticized by 95 percent of the usual commentators. So it takes real courage and stoicism. There was a high probability of depression and the economy was very precarious. Almost any really big bankruptcy could have sent the economy over the brink; possibly even New York City, though I don't believe it would have. Or a big failure of a Euro-dollar bank, a failure of payment by Italy or England. It is easy to write ten scenarios for a serious depression. One problem of the current recession, and it is a problem as well as an asset, is that the liquidity has not really been squeezed out. Normally a depression causes lots of bankruptcies. A lot of debt is written off, which is very painful. But when it is all over, the economy can really take off. Relatively little debt has been written off in this depression. Although it may be objected that many billions of dollars in loans have recently been written off, I still insist that very little debt has been written off in percentages terms.

The U.S. and world economy was actually out of control in 1973. In some ways OPEC helped the non-communist economies of the world out of a very dangerous situation. If the world economic system had continued to be run for two more years in the same way it was in 1973, I think the whole system might have collapsed. I am thinking of a crash on the 1929 model—in depth but not length. Much economic suffering, unemployment, bankruptcies and other losses would have occurred. It is very odd that such a collapse was not foreseen. OPEC, by precipitating this crisis helped prevent the general speculation from getting even more out of control. The U.S. tight money policy goes back to the summer of 1974. It was started by Nixon, not Ford. When the policy was instituted, it was welcomed almost unanimously. Arthur Okun, perhaps the leading Democratic economist, commented: "like a stopped clock that is right twice a day, the administration is right this time." Nevertheless, the public was surprised when the policy produced the painful results which were intended: unemployment and bankruptcies. Thus the recent recession was consciously touched off by the U.S. and Japanese governments, with an assist by West Germany. They did so because they preferred trouble to occur sooner rather than later, for very good reasons.

Reason No. 5 in Table 6 is important; "not as well designed as it could be." When lecturing, I try to dramatize this point by making fun of economists who did not help to raise the level of discussion. I say that I noticed on January 1 that I had a weight problem. I therefore did some empirical research. I weighed myself and then decided to go on a very strict diet. By eating only 800 calories a day, I would lose 75 pounds in one year. But something completely unexpected happened on January 3rd. I got very hungry. This was not a theoretical concept, you understand, these were real hunger pangs. I therefore decided this was a do-nothing policy: other people were eating, and I was not. That's a good definition of a do-nothing policy for a dieter. So I decided that the problem was not my weight, but hunger, (i.e., not a recession, but unemployment) and I went to 1600 calories a day. And on January 4 again something unexpected happened.

⁷ As a result looks like a "do nothing" program to the unsophisticated or biased or dishonest opponents. Actually a more reasonable criticism might be "attempting to do too much too fast."

⁸ Depression is defined as a catastrophic break in the chain of payments. As we judged the odds (say 5 to 1 against) it was a bit like playing Russian Roulette with a six-chambered revolver and one bullet.

⁹ For example we could use indexed mortgages and indexed bonds to improve both toughness of system and rate of recovery without increasing inflationary pressures by very much.

I was still hungry. So I decided on a flexible fine-tuned policy: every day I would eat corresponding to the needs of that day. But I would keep a record. And on the average I would make out. So if on a Monday I ate too much, I would eat less on Tuesday. On these weight issues, it is the average which counts. And that policy works just fine. It has a minor technical flaw, which my staff is trying to deal with—this morning, for example, I had breakfast, January 1st, 1989—the books are a little bit out of balance. But that is very typical of governmental and private policy. I am convinced that the level of academic discussion of U.S. economic policy is no higher than that represented by my story. For example, many economists label the Ford Administration approach a “do-nothing policy.” Yet if one of these critics is shown Table 6, he usually agrees with all five objections (sometimes after discussion, sometimes without). So why then does he call it a do-nothing policy? It might be called a “too-much policy” like my diet of 800 calories a day was too-much policy, not a do-nothing policy. Usually he doesn’t like the policy because of reasons 2, 3, and 4 and considers 1 to be impossible politically. The general expert refusal to recognize that an “economic diet” is exemplified by the “tight money, tight credit, fiscal responsibility, high unemployment, and high unused capacity” and such a “financial diet,” while unpleasant, was the only way to deal with the excess liquidity and inflationary momentum was all the more puzzling, because the overwhelming majority of the lay American public recognized the validity and necessity of the policy.

ANNEX 2

THIRTEEN “NEW” EMPHASES AND TRENDS FOR U.S. VALUES, ATTITUDES, AND GOALS

I would like to discuss here in more detail than in the text the “new” emphases in American life that seem likely to change many of our economic practices and our way of life in both good and bad ways. In particular, I expect that, over the long run, the major reason for a slowing down in U.S. economic growth will be an increasing, perhaps excessive, priority being given to these factors.

The word “new” is placed in quotes because neither the emphases nor the values and goals they react are really new; these issues and preferences have always existed. The key point is that they are beginning to exist in a much more intense, pervasive, and overwhelming way and affect larger and larger areas of our economic, social, and political life.

The new emphases and trends with which we are most concerned can be listed as follows (the categories are slightly arbitrary and not completely distinct):

1. Risk aversion.
2. Localism.
3. Comfort, safety, leisure and health.
4. Protection of environment and ecology.
5. Loss of nerve, will, optimism, confidence, and morale.
6. Public welfare and social justice (including equality of result).
7. Happiness and hedonism.
8. General anti-technology, anti-economic development, anti-middle class attitudes (e.g., “Small is Better” and “Limits-to-Growth” Movements).
9. Many modern family values.
10. General de-emphasis of (or even hostility to) the thirteen traditional levers.
11. Increasing social control and “Overall Planning” of the economy of the “Wrong” sort.
12. Adversary regulatory attitude.
13. Inner space (omphaloskepsis) and/or concern with self generally, perhaps even an emphasis on mystic or transcendental values.

Before discussing each element on the above list in turn, we should mention that Americans can choose among a very large number of “packages” of values and attitudes. As discussed elsewhere,¹⁰ we believe that if this country is healthy, they will tend to prefer the following eight possibilities:

1. High consumption, materialism and other pursuit of middle class sensate and square values.
2. “Neo-gentlemen” (e.g., neo-athenianis mand/or Europeanization of U.S.).
3. Self-actualization (but not consciousness ill).

¹⁰ H. Kahn and B. Bruce-Briggs, *Things To Come* (New York: Macmillan, 1972), Chapter III.

4. Being a human being (neo-epicureanism, familial and altruistic motivations and/or emphasis on warm interpersonal relations and social responsibility).
5. Special projects or programs that create general or specific esprit, élan, pride, excitement, charisma and/or chauvinism.
6. Fulfilling a sense of personal responsibility and a commitment to responsible behavior (neo-stoicism) neo-cynicism.
7. Neo-cynicism.
8. New religiosity (but again not consciousness ill and probably not underground church).

We are suggesting that a general movement towards 1 and 4 is taking place right now, particularly among the New Class. Most of the list below would fit into such a general movement.

1. *Risk Aversion*

We now seem to be trying to decrease many kinds of risks that Americans have normally run, by both lessening the probability that something will go wrong and by compensating much more fully and reliably if things do go wrong—even if in part these dangers are purely hypothetical and may in fact never occur. Even more, we are trying to decrease the possibilities of new risks, even if they are associated with what would otherwise be very desirable innovations. These two trends affect every aspect of our life, from medical practice to the construction of nuclear reactors. In most cases, the new emphasis has occurred not because the dangers have gotten larger (though in many cases they are of a different kind), but because our willingness to tolerate risk has sharply decreased. In some cases, of course, the risks are really new and alarming (e.g., manipulating the genetic inheritance of microbes and viruses, the construction of nuclear reactors, or the stockpiling of nuclear weapons). In many cases programs of “risk aversion” seem to have been carried beyond any useful benefit/cost ratio, even to the counterproductive point where the very risk one is trying to avoid—or a very similar risk—is being increased rather than decreased. Thus in the medical field malpractice suits attempt to protect and reimburse patients, but are actually resulting in the practice of so-called “defensive medicine” which causes the quality of medical care to fall while its cost rises. Our desire to prevent dangerous damage to the environment may well be restricting the accumulation of economic resources and surpluses as well as the advance of technological capabilities, in both of which may lie the solution or alternative to most of the problems which might arise from pollution or if some environmental disaster occurs, particularly if it occurs as the result of natural causes, such as a climate change (which need not necessarily be touched off by human activities).

It is clear that as people become more affluent, they may well wish to take less risks due to societal activities (even if paradoxically they also go in for skiing on dangerous slopes, skin diving at great depths, and hang gliding). And many new technologies do often raise the possibility of unprecedented or unknown dangers in a very alarming way. In fact, they can be even more alarming if the only indication of such danger comes from theoretical calculations involving unreliable assumptions. The uncertainty still is frightening—and the idea of a government or business “playing” with such risks or being callously indifferent to them can be infuriating. Particularly in this case, but even in general, care and prudence can also easily be carried to self-defeating or counterproductive levels. Many medical experts now believe that the cost, time, and other difficulties involved in introducing new drugs for general use in the U.S. have become too large. Not only are many useful remedies never approved at all or are excessively delayed, but these regulations are so deterring that many potentially useful drugs are no longer considered by the companies concerned. The results of all this are probably harming the health and increasing the suffering of the community.

In general, authorities are almost always much more willing to make errors of omission than risk errors of commission. Almost inevitably, if pushed in this direction the system will reach the point where the errors of omission are so great that they overwhelm many of the excessively feared errors of commission. At that point almost everybody would be better off allowing a few more errors of commission in order to decrease this burden created by excessive fear.

We could easily include among the candidates for obsessive concerns various risks associated with unemployment, business failure, price and quality of consumer goods, major financial investments, old age, sickness, etc.

2. Localism

Increasingly in the United States, but particularly on the East and West Coasts but to some degree in the rest of the country, local communities, states, and other areas and regions have decided that they prefer the status quo or slow development to many kinds of rapid economic development and subsequent disturbance or inconvenience. Almost everyone gains by having highways, moderate income housing, factories, airports, and power plants somewhere in his region, but almost everyone loses by having these facilities located in his immediate neighborhood. Even more important, if one moves into a community he likes, he usually does not like to see it change—even if such change is an inevitable accompaniment of what would otherwise be desirable growth.

Until the last decade this conflict has not been severe enough to prevent needed regional facilities from being constructed somewhere—or to prevent outsiders from moving into desirable communities. But recently a series of events and trends has greatly strengthened the hand of local obstructionists. These include:

1. *Disillusionment with progress*: "You can't fight progress" is no longer an unanswerable argument.
2. *Limits to growth movement*: In fact, it's your duty to fight "progress" and one is not being selfish in doing so.
3. *Environmentalism*: (Everything pollutes in some way.)
4. *Anti-auto, anti-noise, anti-traffic agitation*: This problem is especially acute now because many of the New Class are almost maniacally hostile to the automobile and such technical innovations as supersonic aircraft.
5. *Community control*: This concept did little for the poor, but middle-class communities can use it with a vengeance. This situation could eventually resemble one that plagued China before the First World War. Since the Chinese people were almost all ancestor worshippers, any disturbance to cemeteries was deeply resented. But many Chinese communities had existed for many hundreds of years. As a result, it was almost impossible to build a road or a railroad without disturbing many cemeteries. Constructing public projects was therefore quite difficult, particularly if the government did not wish to be too authoritarian.
6. *Widespread disillusionment with governmental and business institutions and leadership*: The dopes or "crooks" either don't know what they are doing or at least have not considered the public interest very much.
7. *Greater acceptance of discretionary behaviors*¹¹ You can fight city hall and get away with it.
8. *Flaccid and sometimes stupid leadership by establishment*: You can not only fight city hall and get away with it, you can often win even when you have a bad case.
9. *Growing affluence*: Economic growth and a greater tax base are no longer so attractive.
10. *Increasing selfishness*: People are more willing both to espouse openly their class or personal interests and to hide them under a very thin veneer of promoting the public interest.

Thus it becomes more difficult to install and operate the infrastructure and facilities for economic development.

The problem may be compounded by tax equalization, revenue sharing, and other legislative or judicial acts which decouple local revenues from local economic activity, thus reducing the incentives for local development.

3. Comfort, Safety, Health and Leisure

Everybody knows that poor or ambitious people often work long hours at tasks which are relatively dangerous, dirty, dull, or otherwise onerous. It seems that the United States will soon have standards which will make it seem unreasonable—or even illegal—for anybody to give up much in the way of comfort, safety, or health to earn a living—and that those who do work will wish more

¹¹ The term is supposed to evoke an analogy with the concept of discretionary income. This is income which a family can spend in almost any way it wishes, without jeopardizing its current or future prospects. Similarly, our current society will tolerate a rather large range of behavior from people which, if the society was operating under desperate or austere conditions, would be judged to be impossible.

leisure than has been customary. This will include not only the poor but also hard-driving executives.

It should be noted that executives who take three months off in the summer are not likely to initiate very risky enterprises which require almost hourly concern and observation.

We should also note here that certain institutions tend to force safety and health measures which really don't matter too much but are adopted anyway and then often turn out to be quite expensive. The whole structure of the unions in which they feel obligated to be militantly active for their members is one example. Even more relevant are ill-advised or ineffective measures by government regulatory authorities which increase costs enormously without actually contributing much to the nominal values which they claim to be furthering. If uncontrolled, just these two institutions by themselves can create some bizarre and costly situations which in turn can have important impacts on economic development or technological advance.

4. *Protection of Environment and Ecology*

I need not emphasize here the extraordinary concern about the environment and the ecology which has been expressed in recent years. Some of it is actually spurious or disingenuous in that it really reflects other values or motives, such as those given in 2 above—i.e., disguises a localism that would otherwise be expressed too nakedly and blatantly. Indeed, such undisguised localism would not be acceptable since it would appear as too hostile to those who are still upwardly-mobile—or to the sympathizers and well wishers of the upwardly-mobile. It is important to cloak this concern for one's own quality of life and almost total lack of concern for that of those who would move into one's community by identifying, as much as possible, with a general disinterested and altruistic concern for the environment or ecology.

Another very big change from traditional values is an almost total lack of interest in recent years (this is improving rapidly) by many leaders of the environmental and ecological movement in the cost of their positions. Thus the first-year delay in the Alaska pipeline, which was more or less caused by the Sierra Club and its collaborators and allies, was probably justified. Since the pipeline was originally badly designed, it should have been, and was, redesigned. But after the review and revisions had taken place, the pipeline was probably reasonably satisfactory; the delay over the next 5 years will cost the United States at least \$50 billion in the balance of payments and even more untold billions in other extra costs for energy—many of which will result in more balance of payments losses. This is simply too much to pay for so little. Yet the people who were responsible for this current and future loss do not seem to have any sense of apology or regret for having done a disservice to their country.

It should be clear to anybody that it is impossible to operate a country without causing damage somewhere: we cannot preserve everything everywhere. My own recommendation would be to divide the country into seven areas, as follows:

Pristine areas:

“A areas”: Minimal interference to environment and minimal risk of damage.

“B areas”: Full restoration of acceptable substitute—e.g., little or no perceived degradation—or even changes.

Normal areas:

“C areas”: Almost any “improvement” and many changes are allowable.

“D areas”: But no eyesores—adequate restoration or substitution.

“E areas”: Economic restoration or substitution encouraged or even subsidized—no real eyesores.

Degradable areas:

“F areas”: Same as “E” but some eyesores and erosion of standards is allowable.

“G areas”: National dumps of various sorts (perhaps as part of a controlled waste management and economic development program).

5. *Loss of Nerve, Will, Optimism, Confidence, and Morale*

The loss of nerve is very general: even the most dedicated technological optimists or enthusiasts for economic growth tend to have some twinges of fear

about where we are going and what may go wrong. In the military field even the most manic advocates of deterrence by Mutual Assured Destruction are concerned about the possibility of accidental or unintended war. (One might note that the acronym for Mutual Assured Destruction is, in fact, MAD.) Almost all knowledgeable people are concerned about some of the potential products of almost all of the hybrid sciences with the prefix "bio." The "management of complexity and change" seems to many to be becoming intolerably complex. Fear of current and future developments inevitably causes some erosion of will, optimism, and confidence which in turn causes both direct and indirect erosion in economic growth and technological advancement. I would argue that in many segments of the population this erosion approaches pathological dimensions which are almost certainly counter-productive. Although public and private decision-makers, engineers, and scientists should undoubtedly be prudent and cautious, even these qualities have their limitations. They should not be carried to the point where they are self-defeating the extreme—or even bring about a cost/benefit ratio which is too low. But the main effect occurs indirectly in political, social, and cultural mechanisms—on career choices, on the attitudes of bureaucrats and voters, on the willingness of families and individuals to make sacrifices. This is going to be particularly true since much of the educational establishment stresses limits to growth thinking and many New Class perspectives excessively. This is certainly the case today, particularly in the so-called "better" schools and prestige institutions. One of my deepest concerns is that these views have been so firmly established and embedded into the educational establishment that unless a conscious campaign and other actions counteract them, they will dominate the education of many young people long after the limits to growth movement itself has lost all credence among most knowledgeable and serious groups.

6. *Public Welfare and Social Justice (Including Equality of Result)*

One of the most important issues of welfare and social justice involves the direct budgeted cost of these programs. We have already suggested that this could slow down economic growth and technological advancement. Thus in the last decade there was almost a doubling of personnel in the cities, many of them hired for the purposes of furthering public welfare and social justice and yet they did very little in this direction, certainly much less than was hoped by those who introduced the programs. But we would like to focus attention here on more subtle psychological and cultural aspects.

The first of these results when in effect "almost everybody feels the state owes them a living" (or at least will guarantee one in practice) or when relief and welfare compete with private industry in terms of economic incentives. There has been much written on these issues and we have little to add to them. We might however make a few remarks on the difference between equality of opportunity and equality of result.

Only recently has a real semblance of equality of opportunity been achieved in the U.S., in the sense that many undesirable discriminatory practices have been brought under a reasonable degree of control. Many still exist, but simply do not have great force. Now, however, many programs of reverse discrimination and lowering of standards not only attempt to correct for real historical disadvantages, but even for assumed historical disadvantages for which there is no real evidence. For example, for many years theoretical physicists have tended to be of Jewish origin. This does not occur because of any special bias by institutions in favor of Jewish physicists. In fact, just the opposite seems to have been true. Similarly, the Irish were disproportionately represented in the New York City police force. My point here is that such numerically lopsided proportions do not represent *a priori* evidence of current discrimination. Furthermore, it is often extremely difficult or costly to correct a historical legacy by reverse discrimination in hiring practices instead of by attacking the legacy directly by educating or otherwise affecting the individuals and families concerned. A low level of reverse discrimination would seem to be generally sensible and constructive in almost every way, and a high level of such policies designed to achieve some kind of numerical quota would seem to be very reasonable in such things as television performers in which the image of the entire community is affected by what they see. But in general, we cannot afford a general leveling of standards in school, business, and government by paying heavy costs in motivation and quality.

The main issue here is not the direct loss of productivity which occurs when one is forced to accept people who are, relatively speaking, inadequately trained or skilled, but the general decline in the standards of the society, particularly in the school system, in order not to "penalize various minority groups with racist tests or standards." Counterproductive programs are another big issue. For example, some evidence now seems to indicate that those Puerto Ricans who live in non-Puerto Rican neighborhoods and are more or less forced to raise their children in an Anglo-Saxon atmosphere achieve about as well as their neighbors. But those Puerto Ricans who are able to go to bi-lingual schools where their old culture is, relatively speaking, preserved and even enhanced find themselves falling far behind. Their compatriots who have been less "indulged," but forced instead to accommodate have acculturated more efficiently and actively. Even if emotional and cultural costs are involved in such a pressurized environment, it is probably still preferable to the alternative, which may seem more sensitive and better tailored to its participants.

7. *Happiness and Hedonism*

To a degree that seems to be unprecedented in any historical culture I am aware of, young people in this country are taught that their goal in life should be some combination of happiness and hedonism, and that they should achieve these by searching for them directly. In almost all cultures, people have been taught that happiness was to be achieved as a more or less reasonable by-product of another activity—satisfactory job, satisfactory family, achievement or success, and so on. Most cultures have not even particularly recognized happiness as an important value. Thus, Sorokin has noted that the search for happiness on earth does not appear as an issue in any written record that has come down to us from European writers of the 6th through the 10th century. In any case, I would argue that the current emphasis on the legitimacy, need, and requirement to search for happiness and hedonism is not only going to cause a great deal of unhappiness as well as some rather unpleasant experiences; it will also result in much lowered economic performance by the individuals concerned—and probably more consumption and less saving. It also can lead to a situation in which all values except those of the extreme secular humanist are degraded or ignored.

It should also be noted that rapid economic development has been associated almost everywhere with sobriety of dress and behavior. This is probably not accidental. Unless people are willing to be extraordinarily business-like and serious about business, i.e., accept Coolidge's position that "the business of America is business," it is not likely that the current momentum will be maintained for very long.

8. *General Anti-Technology, Anti-Economic Development, Anti-Middle Class Attitudes (e.g., "Small is Better" and "Limits-to-Growth" Movements)*

Let us take the modern nation-state with its orientation towards rapid economic growth and technological and scientific advancement as standing for much that people of this persuasion would disapprove of most. I suspect that an agreement with them can be reached by making the following point: The nation-state seems to be one of the most effective institutions ever devised for defense and offense, for promoting economic growth, for gaining influence over others, both internally and externally, and for carrying out big projects. If one has no interest in any of these four activities, then one might well think of the nation-state as a mistake, and therefore not question that "small is better." On the other hand, if one puts much emphasis on any of the above four activities, then the above attitude seems to be without foundation and more likely, if followed blindly, to be counterproductive or destructive than admirable and creative.

9. *Modern Family Values*

This refers to a whole cluster of positions which are characterized by such words as "togetherness," "permissiveness," and "being friends and companions," the need for two-way communications of each side's basic hopes and fears, and so on.

Actually, these new family values may not actually cause the familiar problems that they are often charged with in various discussions. More important may be the change in values which is illustrated by the change in the context of typical soap operas. Thirty or forty years ago, when one watched American soap operas,

one found that if an executive, in the interests of advancement and/or the best interests of his company, drove himself to the point of getting an ulcer, he was considered a hero wounded in the battle for success—and deserving a greater honor than the “unwounded.” Today the same individual would be portrayed as a compulsive neurotic with twisted values. Or to take another illuminating example: In the old-style soap opera, whenever there was a conflict between job and family or between success and family, the conflict was always resolved in favor of the job or success; if not, tragedy would ensue. Today it is reversed. Unless the conflict is resolved in favor of the family or friendship, a tragedy ensues.

10. *General De-Emphasis of (or Even Hostility to) the Thirteen Traditional Levers*¹²

In some way, the 13 traditional levers listed below are almost, though not always, the exact antithesis of much of the modern family values referred to in the preceding paragraph and in much of the preceding material:

1. Religion, tradition, and/or authority—i.e., automatic, and perhaps unthinking respect for the legacy of the past, for continuity, and for the “social contact.”
2. Biology & physics (e.g., pressures of the physical environment and the frailty of life and health, the more tragic aspects of the human condition, the basic and natural “unfairness” of the world, etc.)
3. Defense of frontiers (territoriality).
4. Earning a living—e.g., the five, six, or seven guarantees (Chinese communes often explicitly guarantee to their members: 1) adequate food, 2) adequate clothes, 3) adequate shelter, 4) adequate medical care, and 5) adequate funeral expenses. Sometimes they add: 6) adequate education and 7) adequate pregnancy leave and expenses.)
5. Defense of vital strategic and economic interests.
6. Defense of vital political, moral and morale interests.
7. Other appeals to economic and/or technological rationality and efficiency and/or economic survival type interests, community or national.
8. The manly emphasis—in adolescence: team sports, heroic figures, aggressive and competitive activities, rebellion against “female roles”; in adulthood: playing an adult role (similarly a womanly emphasis).
9. The “puritan ethic” (deferred gratification, work-orientation, advancement-orientation, sublimation of sexual desires, sobriety, good work habits, etc.)
10. A high (perhaps almost total) loyalty, commitment and/or identification with nation, state, city, clan, village, extended family, or secret society.
11. The “martial” virtues—duty, patriotism, honor, heroism, glory, courage, loyalty, and pride.
12. Other sublimation and/or repression of sexual, aggressive, aesthetic and/or “other instincts”.
13. Other “irrational” and/or restricting taboos, rituals, totems, myths, customs and charismas.

In many cases, it is perfectly possible to give a rather high priority to these thirteen traditional levers and still make more than a gesture towards what we call the “new” emphases. And it is not so much that these 13 traditional levers necessarily conflict with the new value systems and goals but that the New Class is often actively hostile toward these levers, regardless of whether they conflict with their own values.

11. *Increasing Social Control and “Overall Planning” of the Economy of the “Wrong Sort”*

Instead of taking the attitude that that government governs best which governs least (e.g., laissez faire), and leaving to the government things that only a government can do or which the government clearly does best, it is now increasingly believed that the government should take an active and positive attitude towards affecting almost every aspect of the economy to achieve ends which have not normally been thought of as the government’s business or at least not within the government’s capability. At the minimum level, the idea is that the

¹² See also *Things to Come*, *op. cit.*

government should establish rules which further all of the new emphases either by direct sanctions and orders or by internalizing costs and benefits of various activities so that the corporation has to take account of these issues. Actually the planning would presumably be constructive if it were done objectively, realistically and efficiently. The problem is that, first of all, most planners simply don't know how difficult overall planning really is. They don't realize how unreliable and old the data are, how misleading the theories are, and how superficial and naive the basic models are, no matter how sophisticated they seem to be from the mathematical and computational points of view. Furthermore, the issue is seldom should there be planning or not but who should do the planning and at what level. Thus one can have broad guidelines laid down for the development of an area, with the actual planning done by builders, contractors, developers and the individuals who buy the homes. The number of planning hours in this second case is an order of magnitude greater than would be involved in a centralized planning authority attempting to carry out the same kind of thing. Furthermore, the quality and intensity of planning is likely to be much better as well. The issue therefore, in this case, does not seem to be planning per se, but who should do the planning and how well will they do it.

In general, even socialist economies are making more active use of market forces, keeping control of very broad strategic decisions, but allowing a good deal of the detail, tactics, and even some possible strategic choices to be worked out by decentralized mechanisms.

It should also be pointed out that so-called indicative planning is not likely to work well in the United States. Despite the claim that it works well in Japan and in France, examination shows that these nations do much less planning than is often assumed and that there is much more coercion and force behind what planning there is. Furthermore and perhaps most important, this planning is done by cadres who come from the best universities and form a rather separate and distinct class which has gained the confidence of businessmen and much of the population as well. It is almost inconceivable that such a group could be found, formed, and take over this function in the United States. Very few businessmen in the United States would accept the idea that the government understood better what was going on than they did. U.S. businessmen do not feel this way about their government, even if they often do in Japan and France.

12. *Adversary Regulatory Attitudes*

This is particularly relevant not only to point 11 above but to many others as well. It is conceivable that the government, in carrying through its programs to promote the "new" emphases, might do so in such a way as to be cooperative and conciliatory towards the existing system and other values and goals, and display real ingenuity, creativity, and common sense when clashes occur—arriving at a genuine synthesis and compromise—with great attention being paid to such issues as economic and technological efficiency and practicality. In fact, the agencies concerned, the legislators, and some of the voters and leaders display an actual hostility towards the system as it exists, as well as a hostility towards the 13 traditional levers. As a result, they do not attempt to introduce these new emphases in the spirit of give-and-take, and with as little disruption and damage as possible, but instead have often almost disregarded the impact of their innovations on the existing system, and sometimes in such a way as almost to deliberately or consciously increase the destructive impact of their new rules and regulations and other activities. In any case, people who identify with these new emphases tend to have very closed minds, and negative, if not hostile, attitudes towards needs of the current system and any complaints or suggestions which originate with its representatives.

13. *Inner Space (Omphaloskepsis) and/or Concern With Self Generally—Perhaps Even an Emphasis on Transcendental Values*

Young people are increasingly preoccupied, not with any objective issues or the goals of the organizations or institutions they are working with, but with "How do I feel about this?" "How am I being changed?" "How do I fit in?" In an extreme form, this takes the place of a kind of inner consciousness that begins to approach some of the manifestations of the Indian culture—a culture which has yet to show much talent at economic development—whatever the worth of its values may be in other areas. Since these other values can be quite worthwhile, this new emphasis is not necessarily unhealthy indeed it may even be

admirable. But such contemplation and preoccupation with one's self are clearly at odds with the sort of outer-directed attitudes associated with duty, self-sacrifice, the work ethic, and achievement spurred by competition and advancement orientation.

Although one may not share some of these new emphases or even completely disagree with them, it can, nevertheless, be a good thing for our society as a whole that people who do share them are exerting pressure on their behalf. It is generally true that things which are everybody's business tend to be nobody's business, i.e., they can be dominated by narrow special interests. In order to achieve balanced results on issues of this kind, it can be very useful for these new strong pressures to counterbalance the influence of groups which normally exert excessively strong pressures in the opposite direction. If we assume that both tendencies tend to be extreme, then a more or less balanced result should usually emerge, which would not of course be the case in the absence of these new emphases.

THE NEW STATE OF THE ECONOMY: THE CHALLENGING PROSPECT

By FRED C. ALLVINE* and FRED A. TARPLEY, Jr.**

SUMMARY, CONCLUSION, AND RECOMMENDATION¹

The record of the U.S. economy during the 1970s has been dismal. We have recorded two back-to-back recessions, the most recent of which is the severest downturn since the Great Depression. This record is in stark relief to the 1960s when we enjoyed the longest peacetime expansion in our economic history. The dramatic reversal of the economy raises the question of what went wrong. Unfortunately, despite considerable effort, few careful examinations have identified what we feel are the fundamental causes for our malaise.

It is the thesis of this paper that in the late 1960s and early 1970s certain fundamental conditions supporting an expanding economy changed, and we have entered into a new era. The problems and prospects are quite different in the economy of the 1970s to those experienced over most of the 20-year period immediately following World War II. A careful assessment must be made of the changed conditions and new policies developed to stabilize the economy and to get it growing once again.

The U.S. economy is suffering from diminished support of several of the major sources of long-run economic growth. Three major changes are indicated below:

1. There has been a shift in societal attitude from a "pro-growth" to a "conservation ethic." Numerous laws were passed in the late 1960s and early 1970s to protect the environment, improve conditions in the work place, and to change buyer-seller relationships. As a result of these laws, the efficiency of the business process has slowed. Great quantities of capital and labor are being used to meet new requirements of the broad set of societally oriented laws.

2. There has been a decline in the pace and impact of economic innovation in U.S. industry. Many of the spectacular post-World War II growth industries are maturing. New innovations are not occurring in significant enough numbers, nor are they of transcending import to offset the maturing of older growth industries. For example, rapid growth and widespread use of the automobile

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following the war opened the "suburban frontier" for conquest. The consequence was a boom in home building, highway construction, shopping centers, office and industrial parks. Unfortunately, suburbia is maturing and the pace of economic activity that went into the conquest of this frontier has declined. Other important post-World War II industries where the growth has slowed include the airlines, television, pharmaceuticals, xerography, and computers. The slowing of growth of these basically post-World War II industries means diminished opportunity for profitable capital investments, fewer new jobs, and less economic growth.

3. The cost of energy that fuels our economy has rapidly increased in the 1970s and is expected to continue to rise for years to come. In marked contrast, during the late 1950s and throughout the 1960s the nominal price of oil and coal was basically constant. This meant, of course, that in real terms the price of these fuels was decreasing. Energy was cheap, and we used it lavishly in the production and consumption of goods and services. The reality of the 1970s is that we can no longer rely on the substitution of cheap energy for more expensive capital and labor resources. Instead, a greater proportion of societal resources must be committed to securing the energy needed to maintain and expand our productive capabilities. Despite these expenditures and the increases in employment and business activities they may bring, the economy will suffer from the realignment among energy and other factor prices. Higher priced oil, natural gas, and coal contains the same B.T.U. per barrel, cubic foot or ton as did the cheaper resources of the past. Society is paying more relatively without receiving additional benefit and the standard of living is not improved in the process.

It is the conclusion of this paper that the economy is suffering from the erosion of three major sources of long-run economic growth. The shift from a pro-growth to a societal conservation ethic, the decline in the rate of new product innovation and the rapid increase in the cost of energy resources means sluggish economic performance similar to what we have experienced in the 1970s. If dramatic swings in the economy are to be avoided and reasonable growth realized, cognizance must be given to these fundamental changes.

To aid in the reconciliation to these new conditions, we make the following recommendations.

Recommendation 1 :

Economists must recognize and respond to the new realities of the U.S. economy of the 1970s.

Unfortunately, the primary intellectual focus of the economics profession has been and continues to be on the demand side of the economy. Elaborate theoretical and mathematical models have been developed to study and analyze problems of aggregate demand. The supply problems which are so important today, and that will continue to be a major difficulty for years to come, have largely been ignored. The economics profession must refocus a good deal of its effort from the demand to the supply side of the economy. It will be necessary to rediscover the origin of economics which was focused on *the allocation of scarce resources among alternative ends*. We must husband our

limited resources and use them in more efficient ways. Ways must also be found to stimulate economic innovation, to reduce governmental imposed restrictions on the efficiency of the business process and to improve upon the productivity of capital and labor.

One of the obvious ways to increase the efficiency of the business process and to stimulate growth is through putting greater emphasis on the competitive process.

Recommendation 2:

The competitive process should be stimulated throughout all segments of the economy. Particular attention should be directed to the service side of the economy.

Where monopoly conditions exist, other than the few true cases of natural monopoly where technological conditions argue for regulation, they should be attacked. The effort to combat monopoly has largely centered on the product side of the economy. However, since World War II most of the growth in employment has occurred in the service side of the economy where approximately half of the work force is now employed.^{1a} Productivity gains in this segment of the economy have been relatively poor,² and the increasing cost of services has been a major source of inflation.³ The professions—medicine, law, dentistry, accounting, pharmacy, etc.—have developed under the banners of standards and codes of ethics, mechanisms which constrain competition and lead to higher prices and often to poorer service.

Another major opportunity for improving efficiency of services is in the regulated industries. There is growing evidence that regulators often protect the regulated, rather than carrying out their responsibility to the general public. This is particularly true in the transportation industry—the airlines, truckers, and railroads. In many instances the cost of the service could be reduced, and the quality of the service improved, by deregulating the industry. The challenge in these less economically exuberant times is to gain improved productivity by introducing long overdue competition into the service side of the economy.

A legacy of the strong performance of the economy over the twenty-five year period following World War II has been a rising expectation for more. When the economy was healthier, the demand for more could be reasonably well satisfied, but that is no longer the situation.

Recommendation 3:

The fires of excessive expectation must be banked. Society has to grow to expect less in order to have more.

^{1a} The Bureau of Labor Statistics divides non-agricultural employment into two categories—goods related (mining, construction, and manufacturing) and service related (government, services, transportation, and public utilities, finance, insurance, real estate, and wholesale and retail trade). When this convention is followed the service related employment increased from 59.1 percent in 1950 to 71.1 percent in 1975. However, it may be argued that wholesaling and retailing should be included in the goods side as opposed to the service side. When this adjustment is made the service side of the economy increased from 38.3 percent in 1950 to 49.2 percent in 1975.

² Unfortunately, our knowledge and techniques for measuring service sector productivity is quite limited (see Second Annual Report of the National Commission on Productivity, March 1973, p. 11). The general impression, however, is that "The increasing relative importance of the service sectors, which is characterized by comparative low levels and low growth rates of productivity as conventionally measured, is also considered a dampening factor (see National Commission on Productivity and Work Quality, Fourth Annual Report, March 1975, p. 14).

³ The Consumer Price Index for all products and services increased 107 percent between 1950 and 1974. In contrast, the price index for all services except rent increased 179 percent. Similarly, medical costs increased 180 percent over the same period. Source: Bureau of Labor Statistics.

As most segments of society including labor—white, gray, blue collar, business, and government press their claim for more, they diminish the ability of the economy to produce. Attempts by each group to improve its position under today's conditions of slow or no economic growth is self defeating. A series of catch-up and cost-of-living wage increases when unaccompanied by sufficient improvement in productivity merely feeds the flames of inflation. Inflation in turn inhibits the efforts of firms to make capital investment in more efficient plant and equipment as needed to increase productivity. Political and labor leaders must struggle to re-establish the linkage between wage increase (and needed all factor payments) and improvement in productivity. The re-establishment of the wage-price guideposts of the early 1960s might aid in this process. With proper modification the Council on Wage and Price Stability could be the mechanisms for mobilizing attention to the relationship between productivity, wages, prices, and profits. Unless this is done, the cancerous effort of inflation will spread, destroying the opportunity for the economy to grow at a level near its potential.

In the second half of the 1960s and during the early 1970s a number of societally oriented laws were passed that impacted heavily on the way in which business operates. There were new and costly requirements relating to (1) the way businesses could use natural resources—the air, water, and land; (2) conditions under which labor could be employed—safety requirements and minority employment ratios; and (3) the relationship between buyers and sellers—a shift from “consumer beware to buyer beware.”

Recommendation 4:

Societally oriented laws must be evaluated not only in terms of the problems they are designed to correct, but also from the standpoint of their impact on the economy.

The problem with the design of many of these laws is that the stress is placed largely on the nature of the problem to be corrected without adequate regard for the cost of meeting the new requirements. For decades we have turned our back on some of the hidden costs of economic progress and pushed these costs off to future generations. It is important that the overdue recognition of these costs not be transformed into over-reaction. Resources allocated to meeting these new concerns may well add little in the way of additional output in a traditional sense, and most likely will come at the expense of added investment which is productive in terms of goods and services.

The cause and effect relationship between these laws and their effect on economic growth is complex, but nonetheless capable of measurement. Laws which had little impact on the balance sheets of either government or private enterprise when first passed, have become increasingly visible as mandated agencies gear up for enforcement and as businessmen respond to these initiatives. An economic impact statement should be required for each of these laws to determine what effect it will have on the economy. The economic impact statements should examine the cost to the economy of meeting proposed standards over different time intervals. In addition, rather than having one absolute standard, various standards should be examined and the cost of each one projected. This would allow explicit recognition of

the trade-offs involved. Finally, alternative ways of accomplishing a goal would be studied. For example, incentives or penalties for performance could be used rather than simply applying across-the-board standards which may or may not deal with the problems and add unnecessary costs where no problem exists.

THE ANALYSIS

In order to understand the prospects and options before us it is necessary to review briefly the quarter century following World War II. We do this not only to put our recommendations in a historical framework, but also since we feel that an understanding of the economic forces that undergird our economy and of how they have changed is absolutely essential to the development of new economic programs, policies, and institutions.

The United States came out of the Second World War with not only a pent-up demand for goods and services, but also a national resolve for policies and institutions supportive of economic growth. The accelerated research and development effort during World War II, coupled with the unexploited reservoir of prewar technology, left the U.S. at the conclusion of the war with a storehouse of economically exploitable technology. Furthermore, at the end of the war the U.S. was blessed with access to large and inexpensive stocks of energy, and over much of the twenty-five-year period the nominal price of energy was constant and the real price was declining. These three forces—

a pro-growth societal ethic,
a storehouse of technological innovation, and
falling real energy prices,

not only reinforced each other, but also formed the basis of twenty-five years of extremely large and consistent economic growth.

FROM A PRO-GROWTH TO A CONSERVATION ETHIC

After the successful conclusion of World War II there was a national consensus that the business cycle could be defeated with national resolution much in the way in which the Axis powers had been defeated. Notwithstanding predictions by the economics profession of a post-war recession, the American public reiterated to its political leaders the desirability of economic growth as a national objective. This purpose was codified in the Employment Act of 1946. This act required that the power of the national government be mobilized to insure the maximum employment of labor and other resources. Economic growth was seen as an unassayed good.

The negative side effects of economic growth—pollution, inequitable treatment of various segments of society, and problems of buyer-seller relationships—were all subordinated to the desire for the production of more goods and services. Smokestacks were seen as the visible symbol of more jobs and more production. Many of America's waterways carried away the costly wastes of business enterprise. Bulldozers tore up sections of cities, and families were forced to relocate to make way for expressway development. Employment policies were left to the discretion of the individual businessman and local custom, regardless

of the effect on members of particular minorities either ethnic or sexual. Businessmen in their conduct of trade were only lightly regulated in buyer-seller relationships. Huge numbers of new products were marketed and snapped up by product-hungry shoppers.

By the late 1960s and early 1970s the national consensus had changed. Society was increasingly less willing to accept the negative externalities associated with growth, and laws were passed which restricted industry's degradation of the environment, interceded on the behalf of minorities in the labor market, and regulated buyer-seller relationships. We shall review each one of these areas.

Pollution

Laws regarding the pollution of the air and water have long existed. In general, however, they were either unenforceable, or state and local authorities having responsibility in this area chose not to enforce them. The 1956 Amendment to the Water Pollution Control Act was significant since it gave the federal government primary authority in this area. It was only in the late 1960s and more importantly in the early 1970s that federal standards were passed for both air and water. The Clean Air Amendments of 1970 declared any and all pollution of the air illegal and gave the Environmental Protection Agency independent status and required it to set acceptable standards for various classes of air pollution.

Similarly, the Water Pollution Amendments of 1972 set as a goal a zero level of discharge by 1985. An interim goal for 1976 was the installation of the most practical technology available to control pollutants. The Federal Council on Environmental Quality estimates that the cost of meeting new air pollution standards for the period 1972-1985 will be between \$135 and \$140 billion. The National Water Commission estimates the cost of meeting standards over the same period to be \$200 billion. Unfortunately, this figure does not include the cost associated with controlling water pollution caused by mining, farming, and urban runoff. When all these are added in, the total cost for all pollution control is \$500 billion. The McGraw-Hill Survey estimated that industry spent 6.2 percent of its total capital expenditure on pollution control equipment in 1974. This diversion of capital occurred in an economy which ranks at or near the bottom when compared to other industrialized countries in percent of G.N.P. dedicated to capital investment.

Human Resources

In the area of human resources the change has been equally dramatic and can be illustrated by the increased concern over safety of the work place and job discrimination. After years of relative neglect, it was in the late 1960s and early 1970s that federal regulation became prominent in this area. The Coal Mine Health and Safety Act of 1969 and the much broader Occupational Safety and Health Act of 1970 are the most important pieces of legislation.

The Coal Mine Health and Safety Act imposed rigid standards on underground coal mining. Small coal operators, either unwilling or unable to meet the new standards, were forced to close down their operations. Mine owners meeting the new standards were forced to increase

the price of their coal by as much as one third. The OSHA required the Labor Department to set standards for every aspect of a firm's operation. OSHA inspectors had the power to close down operations not meeting these standards. One estimate is that 3.3 percent of total new capital investment in manufacturing from 1975-1978 will be spent to comply with these new standards.

The second major focus of societal concern and federal legislation in the area of human resources is in ending job discrimination and equalizing access in the labor market. The Equal Employment Opportunity Commission was established under the Civil Rights Act of 1964. In 1972, EEOC was given independent status and power to sue employers to enforce its orders. By 1974 the case back-log of this commission had reached 100,000. Also under its aegis and that of its sister agency, the Office of Federal Contract Compliance, companies, federal contractors, state government agencies, and educational institutions have had to develop and implement affirmative action programs. These programs have complicated the recruitment, hiring, and promotion process and have required expensive and extensive record keeping. Oftentimes those less qualified have been hired to meet the new requirements. The impact of all this legislation has been to diminish the rate of gain in worker productivity.⁴

Marketing Practices

Another area of societal concern involves the control of the buyer-seller relationships. Early legislation in this area was initiated in 1966 with the Automobile Safety Act. It was merely the vanguard in consumer legislation and was followed by the Fair Packaging and Labeling, Truth in Lending, Toy Safety, Cigarette Packaging and Advertising, and Consumer Product Safety acts. The result of these efforts is that product recalls, corrective advertising, and various other limits on merchandising and promotion have been imposed. An increasing proportion of marketing budgets have been expended on enlarged legal staffs, and efforts have been diverted away from new product development to meeting requirements of various laws. Putting marketing on the defensive has slowed the pace of innovation and new product introduction and has increased the price of existing products.

The legislation discussed above is but a highly visible representation of a fundamental change in societal values. Society has an increasing sensitivity in the areas of environmental quality, human rights, and marketing practices. Strict standards have been set in all of these areas. The effect of each piece of legislation individually, and especially when taken in concert, has been to increase the cost and complexity of pro-

⁴ Specific data on the relationship between societal laws and worker productivity is difficult to obtain. The time lag between passage of the legislation and its full implementation will of course influence the extent of the impact on productivity. Furthermore, productivity figures are very sensitive to stages of the business cycle. An indication of the effect of specific legislation on output per employee can be deduced from the coal industry, before and after the implementation of the Coal Mine Health and Safety Act of 1969. From 1960 to 1970 output increased from 58.4 to 100.3 (1967=100). From 1970 to 1973, after implementation of the act, productivity declined from 100.3 to 89.3. All of these changes cannot be ascribed to the passage of this act, but most authorities argue that the act was the most important occurrence affecting productivity in this industry (Source: Bureau of Labor Statistics). Unfortunately, the effects of the new laws on productivity in other industries are much more subtle and hard to measure. Laws are more general in nature and the time period over which they are implemented is much longer.

ducing goods and services. Capital used for environmental control is not available to expand the capacity to produce. Managerial and administrative time spent meeting requirements of OSHA and the EEOC is not available for making more entrepreneurial decisions. Restrictions on sales promotions designed to protect consumers from possible fraud may end up protecting him from hearing about products which might give him utility.

The objective of economic growth has now been supplemented by quality of life concerns. It may well be that at our stage of development concern over the environment, human values and marketplace relationships is long overdue. But it must also be remembered that economics teaches that choices are necessary with limited resources. Economic growth is now just one among many goals. Implicitly society has been agreeing to pay the price for these commitments to societal concerns by achieving less production. Unfortunately, it has too often been led to believe that these additional concerns were costless.

INNOVATION AND ECONOMIC GROWTH

Technological innovation contributes to economic growth by developing new products, by improving existing products, and by developing more efficient methods of production. During the twenty-five years from the end of World War II to 1970, the U.S. economy benefited from each of these aspects of technological innovation. In fact, few periods of history experienced the unique set of circumstances that produced this golden era in the development and exploitation of innovation.

Conditions conspired to bunch innovations and their exploitation into a short time period. During the depression of the 1930s research and development expenditures were severely curtailed, if not eliminated altogether. Ideas for new products and improvement in existing products and processes languished for lack of funds. This inattention changed drastically with the advent of the Second World War. The threat to this country required that all of America's resources, and particularly its genius for research and innovation, be marshalled for the war effort. Focused research and development was practiced and succeeded to an extent never before even imagined. Out of this research effort aimed at fighting a land, sea, and air world war we developed literally thousands of new ideas which directly or indirectly could later be applied to the civilian economy. Of equal importance, we developed the idea that purposeful research and development could provide a flow of product and process improvements.

At the end of the war our conversion to a civilian economy was buttressed by not only a catalog of new product and process innovations that awaited exploitation, but also by research staffs to design and develop new products. In addition, the skills of the work force had been enhanced as a byproduct of the war effort. When this capacity is matched against a society where the production of civilian goods had been interrupted by, first, ten years of depression and then five years of war, the opportunities were prodigious.

The exploitation of the backlog of innovations provided much of the momentum for the postwar expansion of the economy. To under-

stand the nature of this force, it is important to examine the various stages of innovation and their effect. Major innovations such as television, computers, xerox photocopying, etc., create two types of economic activities. In order to produce the product, investment has to be made in plant and equipment. Sales of the product follow after manufacturing and market effort are undertaken (see Figure 1). Additional investment is attracted into an industry when earlier profit expectations are realized. If market demand continues to grow and the innovation is well received, capital will continue to be attracted into the industry to expand capacity. When sales growth levels off as a market matures, the anticipated and real return from capital declines, thus discouraging further investment.

Life Cycle of a Major Innovation

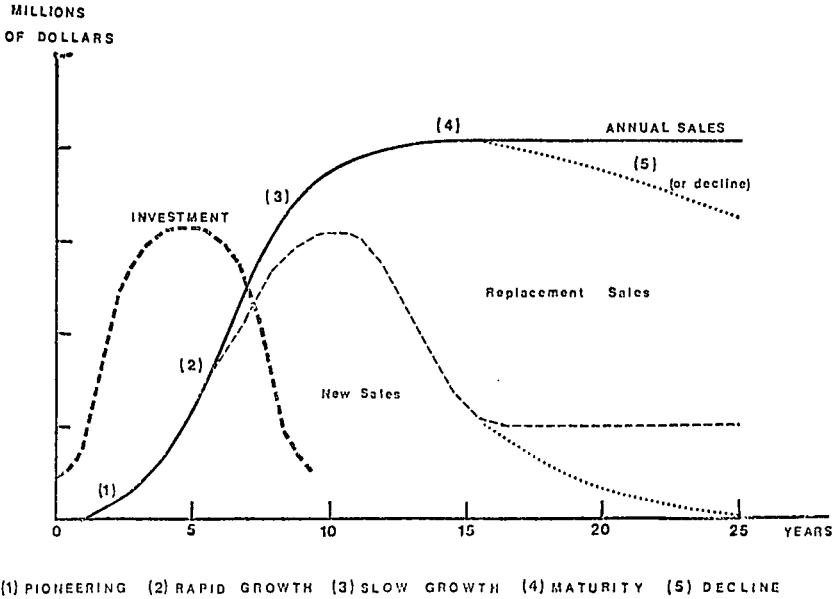


FIGURE 1

The "S" shaped sales curve presents a life cycle view of the market acceptance of a new product or service. In the *pioneering* stage of a new product, sales volume is low as final technical problems are being worked out and marketing activities are begun. Next follows a period of *rapid market growth* during which there is broad public acceptance of the product. Often during this stage there are incremental refinements in the product which further enlarge the size of the market. A period of *slow growth* then sets in during which replacement sales increase in importance. *Market maturity* is reached when sales volume is no longer growing and replacement sales are dominant. The final stage of the life cycle, which may occur only after a long period of time, is that of actual *sales decline*.

During the investment stages and period of rapid sales growth of the innovation, new jobs are created which pump purchasing power into the economy. It is in this manner that new products propel the economy. But when market growth slows and maturity sets in, the industry will do well to maintain current levels of employment. The economy will have lost a source of economic stimulation.

The demand for technologically superior products has not only provided millions of new jobs for the economy but also changed the character of the economy. A dynamic economy is clearly one in which scientific knowledge is being translated into new technology. The continued flow of innovations is of utmost importance for the long-run health of the economy. The twenty-five-year rocket ride was a period supported by major product innovations. The United States entered the period of the 1970s as many of its important innovations were maturing. Unfortunately, they were not being replaced by the new breakthrough advances necessary to generate expansionary waves of investment and employment through the economy.

Truncated Innovations

The most important innovation of the twentieth century was the development of the private motorcar and a series of subsequent innovations based upon it. The full exploitation of this series of innovations was truncated first by the depression and later by the war. At the end of the war in 1945 there were 25 million aged automobiles registered in the United States. By the early 1970s car registration had increased fourfold to over 100 million cars. The U.S. was converted from a society heavily dependent on public transit to a society dominated and formed by the automobile. The importance of the automobile on the U.S. economy is evidenced by the fact that one out of every six workers was employed directly or indirectly in this industry.

As important as the automobile itself was for supporting economic growth, its greater impact may well be in providing additional streams of investment in other economic activity. The development of the suburban living style would surely have been different in form and extent without the automobile. The boom in suburban single-family housing was followed, and in turn followed, vast expenditures on highway and expressway construction. Merchandisers bid against each other to meet the needs of the expanding and affluent suburbs. Neighborhood, community, and regional shopping centers plus discount stores grew to provide a myriad of shopping opportunities for the mobile customers. Office and industrial parks joined the move to the suburbs and added an employment base to these erstwhile bedroom communities. All of these movements required large capital expenditure and in the process provided expanded employment opportunities and gave a large boost to economic growth.

By the 1970s much of the frontier which we labeled suburbia had been conquered. Most urban expressways are in place and many cities have rejected, as either impractical or undesirable, additions to this transportation capacity. Shopping facilities met and often exceeded the requirements of affluent suburbia. For example, in the discount store field which now accounts for some 40 percent of general merchan-

dise sales, new construction is at the lowest level in more than a decade with estimates of some 3,000 vacant discount stores. A similar decline has occurred in the area of shopping centers. Furthermore, most of the convenient and attractive suburban land has been covered by track and other single-family housing. As suburban land became fully occupied, suburbia took on many of the problems that had previously plagued the intercity. Congestion increased, the administrative cost of local government soared, zoning problems multiplied, as did local taxes. It is now estimated that with the average price of new single-family housing exceeding \$44,000, under 25 percent of the families can afford such dwellings. With the acceleration of the purchase price, interest cost, taxes and operating expenses for single-family dwellings, many families are relegated to multi-family housing and mobile homes.

The automobile and suburbanization provided the impetus for an increase in activity which contributed mightily to economic growth from 1945 to 1970. While the automobile industry will continue to be important, and while additional investment will be made in the suburbs, the impact of these activities is not going to approach what has occurred in the past.

Post-War Growth Industries

The period of the late 1940s, 1950s, and up through the middle 1960s was particularly fecund for innovation. Some of these innovations could trace their technological antecedents to the prewar period, some were directly derivative to the massive R and D efforts of the war, and still others were essentially post-World War II phenomena. Together they provided an impetus seldom matched.

Television is an example of a prewar innovation that had to wait until the end of hostilities to have an impact. In 1947 approximately 200,000 television sets were produced. Only three years later, the figure was 7.5 million television sets. By 1960 black and white televisions had matured reaching a saturation level of 90 percent, with three-fourths of new sales for replacement purposes. The introduction of color television in the early 1960s initiated a new wave of growth in this industry. From 150,000 sets in 1962, production climbed to 5 million color sets by 1966. The surge in economic activity not only included that directly involved in tooling-up and producing new color sets, but also investment and activity involved in expanding television broadcasting capabilities at the network and local level along with a variety of support industries. Today, however, color television is in turn maturing with 70 percent of the homes having color sets, and with 60 percent of sales for replacement of existing color sets. The likelihood of another wave of technological innovation, that would match the economic impact of either the advent of black and white television and later color television, seems remote.

Although civilian aviation existed prior to World War II, its significance in the overall transportation scheme was minimal. Over the period from 1945-1970 the number of passenger miles flown increased 37 times and sales revenue 34 times while real GNP itself increased by only one and a half times. This rapid development of civilian avia-

tion was built on the foundations and experiences gained during the Second World War. From 1941 through 1945 over 85 billion dollars was spent on the production of almost 300,000 airplanes. A happy consequence of the war was the new skill of all-weather navigation, a series of technological advances in aircraft design, a cadre of trained pilots, production and maintenance personnel, and most importantly a consciousness of the potentialities of civilian aviation.

Just as in the case of television, the U.S. experienced the stimulating effect of two waves of aircraft development and investment. The first wave was underwritten by the four engine propellor aircraft. These planes could fly at twice the speed, carry four times the number of passengers, at higher and more comfortable altitudes than the two engine planes they replaced. With this improvement in aircraft, civilian flying grew rapidly in the latter 1940s and during the first half of the 1950s. Towards the end of the 1950s the rate of growth in flying had significantly diminished.

In the early 1960s, the rate of growth in civilian aviation accelerated once again as the jet era got underway. The introduction of this generation of aircraft increased the speed, range and in turn the comfort and desirability of flying. The economic impetus provided by the introduction of the jet aircraft lasted until the late 1960s, when despite various modifications and configurations the growth in civilian aviation appreciably slowed. The aircraft technology that will be used for the next decade is already in place. Attempts to introduce supersonic jet aircraft on domestic routes is doomed to failure on economic and environmental grounds. The aircraft production industry is in a replacement mode. It is very unlikely that this sector of the economy will provide the economic impetus that it did in the recent past.

Similar patterns exist for several other post-war growth industries. There has been a significant lessening of single entity and combination drugs. Likewise, the photocopying industry has reproduced an almost identical pattern. The leading firm in this industry, Xerox, saw its sales increase some 47 times during the decade of the 1960s. Employment leaped from 3,000 in 1960 to 55,000 in 1970 and stockholder investment increased by almost 50 times. By the late 1970s, Xerox by its own forecast will be growing at a modest 8-9 percent a year.

As our brief review of four of the more important industries has shown, technological maturity has come to one-time important growth industries of the U.S. economy. The increase in jobs, investment opportunities and economic growth associated with these and other growth industries is hard to replace. Technological advances and product innovations will continue to occur. The important question is whether they will be in sufficient quantity and import to replace the stimulus provided by the now maturing technologies.

The peculiar juxtaposition of a depression followed by a war led to a unique grouping of exploitable innovations as discussed. These innovations were of such magnitude and import to serve as the basis for revitalizing moribund industries and for developing many new industries. Unfortunately, events have conspired to limit the number and potential of transforming types of innovations in the foreseeable future. Many of the recent and prospective innovations have been incremental rather than transforming in character. The digital watch, solid state television, and mini-calculators all represent advances, but

basically perform the same function albeit more rapidly and conveniently than their predecessors. A look at the future shows a few bright spots surrounded by dark images. For example, MPUs, the computer on a chip, is the kind of advance which could be more than incremental. Unfortunately, there is a dearth of such innovations on the horizon. As we move away from a goods economy toward a service economy, innovations become more difficult. Recent figures on expenditures for research and development, of both government and the private sector, reinforce our judgment.

ESCALATING ENERGY COSTS

Many of the post-World War II technological advancements were energy intensive. The nature of many product and process innovations and their extent of development resulted from the U.S. having large stocks of cheap energy resources. The prominence of America in energy consumption is both a cause of, and results from, its high level of economic attainment. With only six percent of the world's population, the U.S. consumes approximately one third of the world's energy.

From the latter 1950s until 1970, the nominal price of petroleum, coal and electricity decreased. Over this same period, natural gas prices increased, but at a relatively modest rate. When account is taken of general inflation in the economy, the real price of these energy resources declined dramatically. This encouraged the process of substituting relatively less expensive energy for more expensive labor, capital and material resources. The favorable energy prices facilitated and extended our record of economic growth. Whether by design or accident, it is nonetheless true that from 1945 to 1970 the increase in real GNP and the increased use of energy almost exactly tracked each other.

Energy does not abide by the laws of Newtonian physics would hold that everything is reversible. Instead, it more nearly conforms to the laws of thermodynamics which hold that energy once used is lost forever. Energy is clearly a depletable resource. As a depletable resource it is foolish to expect it to be provided at constant or falling prices. This is an Impossible Dream. It runs contrary to the logic of resource economics which suggests that increasing utilization of depleting resources cannot long occur at falling prices, but instead at higher prices. We delayed but could not repeal the principles of resource economics. The day of reckoning is at hand. Our energy dream is in the process of being exchanged for a nightmare.

To understand how we achieved and maintained our favorable energy posture it is necessary to briefly review our energy circumstances. The primary sources of energy—coal, oil and natural gas—are highly substitutable. During the 20-year postwar period, petroleum and natural gas was increasingly eroding the traditional markets long dominated by coal. For the period as a whole the energy derived from petroleum tripled, from natural gas quintupled, while coal usage dropped slightly. Electricity consumption increased sixfold.

Petroleum maintained its favorable competitive relationship primarily due to increasing imports from South America and the Middle East. Natural gas prices were held down by the Federal Power Commission which regulated wellhead prices. Coal was struggling mightily

to maintain its largest remaining market—the electrical utilities—against the combined blows of cheap imported oil, low price natural gas and a future made uncertain by the prospects for nuclear power.

The economic impact from the thermodynamics imperative can be postponed, as the quarter century following the war demonstrated. However, eventually the day of reckoning occurs as events of the 1970s clearly demonstrate. The Oil Producing and Exporting Countries (abbreviated OPEC) formed an effective cartel which used supply limitation to quintuple the price they charged for oil from 1970 to 1975. Over the same time period of the early 1970s, domestic production of oil peaked and has since declined. The U.S. was unable to meet foreign supply restrictions with increased domestic production. Fifteen years of holding down the price of natural gas has stimulated demand and retarded exploration. As a result natural gas production also has peaked and declined in the early 1970s. The coal industry faced with uncertain prospects failed to increase its capacity. The combination of all these forces resulted in a severe energy shortage with rapidly escalating fuel prices.

Even the most sanguine forecast indicated our continued dependence on the traditional sources of energy for the remainder of the century. Unfortunately, future energy is going to be developed and made available at higher prices. OPEC appreciates the extent and the growing nature of our dependence on foreign oil resources, and has given every indication of continued price increase. Additional production of increasingly more costly domestic oil and gas means higher and higher prices. Further, utilization of our abundant coal resources will also be at higher prices due to more stringent environmental standards.

Optimistic forecasts have been made for new energy sources which hopefully would ameliorate our present energy problem. Coal gasification and shale oil hold some promise in meeting our future energy needs. However, many problems must be solved before these technologies become commercially feasible. Current estimates indicate that their contribution will be minimal to meeting our growing energy needs.

Almost from its inception nuclear power has been promoted as the coming energy source. But three decades of experience has moderated its expected contribution. Continued escalation of plant and fuel cost have combined with continuing questions concerning reliability and safety to adversely impact on the economic and political acceptability of nuclear power. Any hope of nuclear power playing a dominant role in our energy future awaits the development and commercialization of the breeder reactor. Many experts question the feasibility of the breeder reactor and most agree that if it is to make a contribution this will be after the turn of the century.

Solar energy utilizes a nondepletable energy resource and as such it provides new hope for the future. However, most analysts agree that solar energy will become economically attractive only when the price of traditional energy resources is much higher than it is at the present time.

Cheap and abundant energy was a major factor contributing to the twenty-five year period of economic growth following the war. Events

have conspired to eliminate this factor in support of growth. Cheap energy can no longer be substituted for other resources, indeed the substitution will be in the other direction. Conservation rather than profligate use is the challenge of the times. The new energy climate must be considered a negative factor in assessing future growth prospects.

ECONOMICS PROFESSION AND THE NEW REALITY

The post-World War II quarter century found the economics profession playing an increasingly prominent role in discussion of economic and social policy. This new-found prominence of the economics profession rested on two pillars. First, Keynesian economics gave the profession an intellectual framework which was conducive to prescribing policy initiatives for short-run management of the economy. Fiscal and monetary policies became tools which political authorities could use to move the economy towards fuller utilization of labor and capital resources.

The second major pillar on which the importance of the economics profession was erected was the economic record from 1945 to 1970. This twenty-five-year time span was a period of almost continuous economic growth that was interrupted by only mild recessions. The profession basked in the reflected glory of the performance of the economy.

Much of the economics profession and the public at large ascribed a certain causality to what economists were saying and doing and to what was happening in the economy. Unfortunately, many economists failed to appropriately analyze the fundamental strengths of the post-World War II economy. They failed to appreciate that much of the strong performance of the economy was due to a pro-growth societal ethic, cheap and abundant energy, and a large storehouse of unexploited economic innovations. An exaggerated importance was ascribed to the economist's ability to obtain growth and stability through manipulation of the short-run tools of fiscal and monetary policy.

The economics profession expended great effort during the twenty-five-year period in developing and elaborating models, theories, and tools aimed at controlling short-run fluctuations in the economy. The extent of this commitment is hard to over-emphasize. Indeed the very nature of economics and the economics profession changed as a result of this new-found commitment. The social science roots of economics were greatly de-emphasized, and the direction was towards emulating the physical sciences. This movement was aided and abetted by increasing attempts to mathematize economics. Statistical manipulation and theoretical sophistication were increasingly valued. The goal became that of developing a value-free social science. This led increasingly to the professionalization of economics. In the minds of the practitioner, and increasingly to the public, economics became a very sophisticated and complex subject matter. It was accessible only to practitioners who had served lengthy apprenticeships and who ascribed to the philosophy of the physical sciences.

Just as much of the economic profession failed to identify the fundamental forces which provided strength to the post-World War II economy, they have similarly failed to gauge the erosion which has occurred in these forces. Given the inadequacy of economic knowledge, most economists have called for different dosages of fiscal and monetary policy as the remedy for our present economic malady. Trying to solve long-run growth problems with the short-run tools of fiscal and monetary policy contributed to the worst downturn in the economy since the Great Depression.

In addition, the primary focus of the economics profession has been largely demand oriented. Supply problems by their very nature tend to be long-run considerations. Much of recent economic analysis and policy prescription have treated elements of supply conditions as constants. Inadequate attention has been directed to technological change and innovation, resource development and pricing, the impact of government policy on economic growth, and ways to increase productivity. Continued preoccupation with short-run stabilization policies and procedures just postpones the day when progress can be made in meeting the long-run problems and concerns.

If we are to experience future economic growth and stability, specific attention must be given to the supply side of the economy. However, a change in orientation of the order needed will not be an easy task. Economists have invested three decades of primary emphasis on problems of short-run aggregate demand. Economists must realize that they have to leave the sophisticated and highly developed world where they have dwelled the past 30 years, and enter the underdeveloped area of long-run supply problems, which remains unmapped. This journey requires that the economist accept a different view of himself and his profession. He no longer is aided by the sophistication of his model and the reassuring belief that he has the requisite answers. His major challenge is to accept the enormity of his own ignorance, and from this humble post begin to develop meaningful theories, analyses, and policy prescriptions.

The rewards of this journey are a new relevance. Economics will be returning to its roots as a philosophical and social science. Economics will again become the study of utilizing scarce resources in an efficient manner. We will again worry about how to increase the wealth of the nation. The long-run problems that occur on the supply side must be solved if our future short-run options are to prove both meaningful and enduring.

ECONOMICS AND MANKIND'S ECOLOGICAL PROBLEM

By NICHOLAS GEORGESCU-ROEGEN*

SUMMARY

The problem of man's relationship with the environment cannot be reduced to what the price of gasoline should be tomorrow or how much oil the United States will have to import in 1990. This problem is not economic in that narrow sense. Its nature is bioeconomic, for it involves the special mode of life of mankind as a biological species. Only if we view it in this very broad perspective can our steps into the uncertain future be guided in full knowledge of the nature of the issues of which we have become aware only recently under the pressure of events, without, however, fully realizing their momentous dimensions. The entire picture may at first appear as a mosaic, but its flawless unity will emerge in full view after the connections between all the pieces are analyzed and established.

All species, including ours, have evolved through biological mutations, which usually (but not always) render the individual better fit for life. Only the human species transgressed this extremely slow mode of progress as it began to use and later to produce "detachable limbs"—a club at first, jet-propelled wings, and electronic brains in our own time. We have thus acquired organs that do not belong to our bodies—exosomatic organs, as they may be called—which we could not have developed on the biological track. But the important point we have failed to realize is that this unique evolutionary feat brought upon mankind some predicaments which, from what we can tell, are irreducible.

The first predicament is man's dependence on terrestrial resources in a staggering degree. Man is now a true geological agent, drilling and digging the bowels of the earth for the energy and materials with which to produce his detachable limbs. Almost all of mankind thus became addicted to the comfort and delight offered by these limbs in a sense of "addicted" for which there is no other correspondent. We are addicted to that comfort, be it reasonable or extravagant, just as we are addicted to food, for example. An abrupt restriction of the use of our detachable limbs will produce unimaginable withdrawal spasms. If the use of any exosomatic organ were stopped for only a few weeks in this country, casualties will most probably exceed by far the number of dead during the last three wars. Yes, we do not live on bread alone, but *also on natural resources*.

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Our addiction to exosomatic enjoyment is unique in still another way. So far no one has died of an overdose. To wit, we, in this country, feed our addiction far more intensively than the rest of the world (in some cases, one hundred times more), and nevertheless we are still going strong—or so, we think. The United States, in particular, has thought of gradually eliminating this difference between the developed and the underdeveloped. If the substantial effort has remained without effect, it is because the approach was based on the standard economic view—with money you can do anything. At this late hour, it is imperative that the overdeveloped move in mass to save the underdeveloped by sending them factories, not to produce their own luxuries (like most of those built with past aid), but their own food for the years ahead.

The problem touches our moral fiber, to be sure, but it grows out of the second predicament brought by the exosomatic evolution. Because of this evolution, mankind has always been divided into exosomatic *species*, just as different from one another as biological species are. Exosomatically, *Homo Americanus* may be characterized by the self-starting, self-cleaning microwave oven; *Homo Indicus*, instead, cooks in a primitive contraption which burns dry dung. Since the difference is bioeconomic in nature, it can be eliminated only by a development at the exosomatic level of the underdeveloped. We have just developed a microwave that “has changed America’s way of cooking.” What is in fact needed urgently is a cooking utensil that would change the way the underdeveloped cook. Because we have not been able to see the real nature of the problem, no R & D, in the developed or underdeveloped countries, has ever thought of trying to design such a utensil. This is the tragedy of the inequality that makes the whole world now boiling with unhappiness and ominous unrest.

For the sake of completion and because the point bears upon some solutions to mankind’s welfare, I shall mention also the third predicament deriving from the exosomatic evolution. Since production of detachable limbs requires an organized society, human communities came to be divided from the dawn of civilization into “governors” and “governed”, in the broadest sense of these terms. The ensuing social conflict may be kept at a low flame, but it cannot be completely eliminated (unless man returns to the simple life of the traditional village or even to a more primitive one). As long as production has to be organized and supervised, there will be either presidents or commissars, either chairmen of the party or kings and emperors, and so on down the line. This predicament has its second root in the fact that, in contrast with other social species, we have not come to live in society by biological evolution. Humans are not born so that each individual be fit only for some particular role. The biological constitution at birth of a human may fit the role of a ricksha man just as well as that of a mandarin.

History, past and present, proves that man’s struggle to obtain control over the terrestrial resources dominates this entire picture. If standard and Marxist economics have completely disregarded the role of natural resources, it is only because of the fantastic mineralogical bonanza which the developed countries (where both economics originated) have enjoyed for the last two hundred years or so. It may seem hard, because it is unpleasant, to think that this bonanza may be a unique episode in the long life of mankind. Yet it most certainly is so.

When one's pantry is stocked up with far more things than one can use immediately, one not only may lose sight of its finitude but one also is apt to believe in an endless availability of resources. In fact, people once believed in perpetual motions—at first even in the inexhaustible nature of electricity. The science of thermodynamics has cleared up such myths, although some still linger on dangerously.

In essence, thermodynamics is a physics of economic value, i.e., a science concerned with the particular physical quality that makes some things have a value for man. From this anthropomorphic viewpoint, thermodynamics divided energy and matter into two qualities—available to man for his life purposes, and nonavailable. Matter-energy, while remaining continuously constant, may change its quality, but—and this is an important point—always by the degradation of available into nonavailable form. The existence of this irrevocable degradation is the meaning of the Entropy Law—a law much quoted nowadays but often little understood. The degradation goes on all the time in the material realm, although some living creatures (the green plants) slow it down, while others (especially, man) accelerate it. When we drive an automobile or heat our homes with some coal, we cause an irrevocable degradation of energy available to us into a form no longer useful to us—dissipated heat, fumes, smoke, ashes, etc., briefly, into waste and pollution. That we can use the available energy of a gallon of gasoline only once is by now a commonplace. But an automobile tire, for example, can also be used only once. Therefore, the full meaning of the Entropy Law is that unavailable matter-energy continuously increases. And since entropy is a relative index of the amount of unavailable energy in a system, we may also say that entropy continuously increases.

In view of these thermodynamic laws, it is certainly inept to push aside the scarcity of matter by the idea that the whole earth is made of matter. The rub is that not all the earth is made of matter accessible to us. The same applies to energy, which as thermal energy exists in fantastic amounts in the ocean waters but is completely unavailable use in the engines of ships.

The fact that our terrestrial dowry is finite and can be used only once is the crux of mankind's ecological problem, for which economics cannot be of much help. Market prices are parochial elements. And it was because prices were right that deforestation took place on a scale we now bitterly regret. Some future generations will be short of plowshares just because the present prices of Cadillacs or Rolls Royces are just right for production.

Even technology has not always moved in the right direction of true ecological economy. The most salient example is mechanized agriculture, which has replaced organic agriculture, a system relying mainly on solar energy, by a system relying exclusively on terrestrial energy. Think of the fact that the solar energy received in two weeks is equal to that of the entire fossil fuel reserves, whereas the sun will shine for another 200 billion weeks.

Some have claimed that the earth could feed even a population of fifty billion. But none has stopped to ask the question, "for how long?" The greater the pressure of population on land, the greater the cost in scarce terrestrial resource per man. Recently, we have heard of the ecological salvation lying in a stationary economy. But this thesis fails

to offer any criterion for the optimal size of population. The only criterion is that population must at all times remain at the level which can be fed by organic agriculture. But we should not be mistaken: even a stationary population will continue to deplete the terrestrial stock of matter-energy and increase population and the dissipation of matter. Man's mode of life cannot possibly remain stationary. Struggle is an inevitable feature of life, especially, of man's.

Given the restrictions and the pressure of an increasing population, given also the interest which we ought to have in the well-being of the future generations, we must arrive at a reasonable policy to deal with the ecological problem before it is too late.

Plans like Project Independence as well as advertising technical means which are not yet available (some, possibly, not even feasible at all) are fraught with danger. We must not be guided by illusions of one sort or another. We must wait until we can block out gravitation before we sell shares in houses without staircases and elevators.

The only effective policy is to act on demand—as nations have always done in times of scarcity—and welcome the innovations only after they take shape. To economize is the most elementary principle of economics. There are numberless activities with which we can splendidly dispense. Fashion is one of them. The use of two-car garages and of such things as the golf cart is another one. Still worse, *we are now beating the plowshares of future generations into present swords.* Our ecological temper is, however, dominated by "bigger and better" depletion and pollution, by "no deposit-no return," and by "when the blades ultimately become dull, you just toss the whole razor away."

For these reasons, the faucets through which terrestrial matter-energy pours into the economic process and the drains by which waste returns to the environment must be put under a control independent of the market or any ownership. However, the internal allocation should be left to the market, the only computer which, if well supervised, can solve for each generation the immense system of optimization of given ends with given means (as the textbooks say).

Such a bioeconomic program stands no chance of being implemented if our scale of values is not reoriented, not only in this country, but everywhere in the world, according to the commandment that seems to be dictated by the present evolutionary momentum of our species:

"Love thy species as thyself."

These are the points which will be examined in this paper in some detail.

I. THE MECHANISTIC PHILOSOPHY OF STANDARD ECONOMICS

Standard economics—that is, the economic science as has been practiced during the last one hundred years or so—defines itself as the study of how scarce resources are administrated. It is only as one becomes acquainted with the teachings of this discipline that one discovers that its definition leaves one important thing unsaid. By "resources" standard economics understands only labor, capital, and Ricardian land (i.e., land as mere space). The role played by natural resources in the economic process is completely ignored.

The omission is highly intriguing and has recently become the cause of some embarrassment. For even a cursory reading of history would have shown that control over the mineral resources has been and still is one of the most important factors, if not the most important factor, of political struggles between nations—struggles which have their fateful social repercussions within each nation. At the same time, we must recognize that standard economists may invoke some circumstantial reasons for that omission.

First, the true industrial revolution (which actually began as far back as the thirteenth century) acquired a fantastic momentum because of the mineralogical bonanza which paralleled it especially from the second half of the nineteenth century on. Iron, copper, tin, and lead, for example, had been mined and smelted since old. Glass, too, had been produced by basically the same technique long before what in economics is called the Industrial Revolution. Only, the fire power used to come from wood, instead of coal or oil. Factories had to move from one place to another after the supply of wood from the neighboring forests was exhausted. The industrial activity of that epoch was the main cause of the vast deforestation everywhere in the world.

The emergence of the modern mineralogical bonanza caused a substantial change in mankind's evolution. Because of it, man became a geological agent—an agent that interferes with the geological strata of the globe. It also led to the belief—so clearly expressed and insistently defended by Karl Marx—that nature offers us its treasure gratis.¹ Standard economists, too, took the position that all one has to do in order to obtain some iron or coal, or oil, is to expend some “resources”—labor and capital—in an appropriate location. Because of the mineralogical bonanza, all were led to believe that such a location could be found at will with only some additional expenditure of the same kind of “resources”. Even at this hour, many believe that all we need to produce more energy and solve the ecological crisis through some kind of Program Independence is to have command over enough money.

Another factor responsible for the omission of natural resources from the vision of the economic process is the mechanistic epistemology to which the founders of standard economics and their followers to the present day have clung with a blind force. Mechanics allows only for a change of place, for locomotion, which is completely reversible. In no mechanical analogue, therefore, can there be room for irrevocably exhaustible resources. But, as it happened, the mechanistic dogma enjoyed an unparalleled prestige until well into the second half of the nineteenth century. To recall, Laplace felt completely justified to maintain in his famous apotheosis of mechanics (1814) that absolutely everything in the whole universe is completely determined by a vast system of mechanical equations. The sole concession he made was that only an intellectual demon could possibly solve such a system. But some years later, in 1846, a “miracle” happened. Urbain Leverrier discovered the planet Neptune, not by scanning the firmament with a powerful telescope, but at the tip of his pencil following some calcula-

¹ Curiously, even Marx noted, however in passing, that “It appears paradoxical to assert that uncaught fish, for instance, are means of production in the fishing industry. But hitherto no one has discovered the art of catching fish in waters that contain none” (*Capital*, I, p. 201 note).

tions based on the equations of mechanics. What Laplace had only envisioned now seemed to become a fact. What a beautiful dream for social scientists Leverrier's feat must have then inspired! Think of an economist being able to calculate the position of a particular share on the firmament of the Stock Exchange Market tomorrow or, even better, one year from now.

The most important cause, however, of the uniquely resilient adherence to the mechanistic epistemology not only of economists, but also of many other students, is one lasting propensity of how human understanding works. Probably because we can act only by pushing or pulling, i.e., in a mechanical fashion, our minds feel a strong attraction for mechanical explanations. A great physicist, Lord Kelvin, admitted that "I can never satisfy myself until I can make a mechanical model of a thing." The history of nineteenth century physics is very telling in this respect.

Shortly after Laplace extolled the power of mechanics, Sadi Carnot (an officer in the French Engineer Corps) became interested not in celestial affairs—as Laplace and others had always been—but in a quite pedestrian problem. The problem was the efficiency of steam engines, of the power of fire, as Carnot described it. His memoir of 1824 ultimately forced upon physicists the surprising discovery that, after all, mechanics cannot account for every happening in the universe. It cannot explain the simple and faithfully constant phenomenon of heat always passing by itself from the hotter to the colder body, *never in reverse*. The laws of mechanics allow any mechanical phenomenon to go in reverse as well, as best exemplified by a pendulum. To wit, the earth could very well have moved in the opposite direction on the ecliptic; no mechanical law would have been violated thereby. But if heat moved by itself from a colder to a hotter body, one law of thermodynamics—the peculiar science that grew out of Carnot's memoir—would be defeated. Subsequent discoveries of the same nature—in radioactivity and quantum mechanics—caused the mechanistic dogma to be abandoned by physics itself.² However, although this reorientation appeared in all open pronouncements, most physicists have remained mechanistic under the skin. They have continued to thank "mechanically" and even have striven to erect a new thermodynamics—the so-called statistical thermodynamics—on a mechanical foundation. The attempt, naturally, produced a movement of logical contradictions and epistemological incongruities.³ In view of all this, the fact that the Kelvinian complex has gotten the better of standard economists should not surprise us greatly.

The mechanistic foundation of standard economics shows up not only in the terminology borrowed from mechanics—equilibrium, elasticity, statics, dynamics, etc.—but especially in the conventional argument of how the outcome of a market swings back and forth as demand and supply schedules shift back and forth. A physicist or an engineer would be surprised to learn the way in which the outcome of a market is proved, for that proof is completely identical to that for static mechanical equilibria by the principle of virtual displacements. Just as in mechanics, such shifts and displacements leave no trace of

² Einstein and Infeld (1938), ter Haar (1959).

³ Georgescu-Roegen (1971).

their occurrence. There is no way by which a mechanical framework could reflect the irreversible effect, the indelible marks, left on the process itself by an inflation, a drought, or a war. But nothing reveals the deep-seated mechanistic philosophy of the current doctrine as the ultrafamiliar diagram by which the economic process is portrayed in practically all economic manuals, including those authored by some of the highest authorities of the profession. (See figure 1, p. 89.) According to the standard vision, the economic process is a self-contained and self-sustaining circular affair—a merry-go-round between “production” and “consumption”. In good agreement with the laws of mechanics, the arrows in that graph could very well have been drawn in the opposite direction. Because money may seem to run in circles, a money fetishism characteristic of business practice must have constituted still another cause for the circular vision of the economic process. On further thought, however, one should have realized that even the symbols of money wear out and must be replenished by new material. The object lesson is that an adequate representation of the nature of the economic process must rest on the notion, however unacceptable on vulgar grounds, that money does not count at all as far as the essence of the economic phenomena is concerned.

The main purpose of this paper is to prove what really counts. However, the foregoing remarks suffice to prove, first, that an economic science constructed on a mechanistic scaffold cannot deal with the ecological problems indissolubly associated with the economic process and to suggest, second, that without going beyond the monetary veil we cannot even perceive these problems. However, the full story has still more details which can be related only in part within the scope of a single paper.

II. THERMODYNAMICS AND THE NATURE OF THE ECONOMIC PROCESS

Between the economic process and the life processes of any living organism, wherever such organisms may exist in the universe, there exist numberless affinities, for the economic process is nothing but an extension of the biological evolution. All living creatures, man included, have become better adapted to life by the accumulation of one favorable biological mutation after another. But this mode of progressing is extremely slow. It took forty-five million years for the *Eohippus*—an animal which in the Eocene era was no bigger than a beagle—to become by biological evolution the powerful horse of our time. The human species was able to embark on a faster mode of progress. Apart from one other species—namely, the marginal, albeit instructive case of the woodpecker finch of Galapagos Islands—man alone began producing “organs” instead of waiting for mutations to endow him with them. Ever since the dawn of his existence, man has produced detachable limbs—organs which do not belong to his body—such as a club, a hammer, a knife, and, more recently, a submarine or an airplane. Moreover, as Joseph A. Schumpeter so admirably showed, these *exosomatic* mutations⁴—viz technological innovations—are governed by laws analogous to those of biological evolution. The unique message of Alfred Marshall that biology, not mechanical dynamics, is

⁴ Exosomatic, because they are outside the *soma*, the body.

the Mecca of the economist is vindicated above and beyond his original intent.⁵

Like all life processes, the economic process is firmly anchored in the material environment. This is a simple fact. But what we must not fail to realize is that the relationship between all these processes and the environment is a dialectical one. As is especially visible in the case of the economic process, this process continuously changes the environment and is, in turn, affected by that change. Grazing and over-grazing years on end of the steppes of Central Asia by sheep-growing peoples led to the impoverishment of the soil. This ecological cornering then triggered the Great Migration, which lasted for almost one thousand years and changed completely the economic, social, and political face of Europe. The pressure of population and land was also responsible in large measure for the more recent migration from the Old to the New World. An even more instructive example: because of the increasing deforestation mentioned earlier, the old industrial activities had to turn to coal, at first a less profitable source of fire power. The result was that the art of mining was gradually improved to the extent that mining (not only of coal) became highly profitable and all minerals became accessible in apparently endless quantities. Economic historians, as well as anthropologists, have kept hammering at this dialectical evolution. But their achievements have met with the indifference—at times even with the disdain—of standard economists.⁶

One important articulation of the economic process hinges, as I shall explain in detail presently, on a fact brought to light by the Carnotian revolution—namely, that the material universe undergoes *from within itself and by itself* a continuous and irrevocable change in one particular direction. For their failure to take account of this revolution, standard economists of latter days can no longer invoke any circumstantial reasons. Actually, this revolution was an accomplished fact at the time when one of the Neoclassical forefathers, W. Stanley Jevons, set out to build the modern economic science as “*the mechanics of utility and self-interest.*”⁷ Still more aggravating is the fact that thermodynamics—a well established branch of physics by that time—is in essence a physics of economic value. Indeed, Carnot, because he was intent to analyze the quantitative efficiency of fire in steam engines, may be rightly regarded as the first genuine econometrician.⁸

Two disciplines, thermodynamics and biology, are the necessary torches for illuminating the economic process and discovering its main articulations. This advice⁹ seems now to have been largely heard. Witness the fact that almost everyone—from ecologists to the die-hard defenders of the standard conception—is expatiating on the connection between thermodynamics and the economic process.¹⁰ Even some Cornucopian economists now recognize that mankind’s dowry of ac-

⁵ Georgescu-Roegen (1974), (1975a), and (1975b).

⁶ To cite a salient example (because the author in point is a very distinguished economist), W. J. Baumol (1970) thinks that works such as those of Karl Marx and Joseph Schumpeter are “vague and impressionistic”.

⁷ Highly curious, only six years earlier, Jevons aired his apprehensions about the exhaustion of England’s coal in a voluminous, well-argued study, *The Coal Question*.

⁸ Georgescu-Roegen (1966) and (1971).

⁹ Georgescu-Roegen (1965), (1966), (1970), (1971).

¹⁰ E.g., Barry Commoner (1976); Robert Solow (1974).

cessible resources is finite in a sense that bears upon the survival of our species. Anatoly Aleksandrov, the President of the USSR Academy of Sciences, has also recently admitted (however implicitly) that oil and gas are becoming increasingly scarce; that nature, after all, is not a gratuitous provider forever (as Marx held).

Although no bandwagoning has been as spectacular, the new reorientation does not seem to have been accomplished by a correct understanding of the whirlpool of matter and energy on which mankind's existence depends. To be sure, the thermodynamic principles seem extremely simple on the surface. However, their implications and applications are quite involved—a fact which most authors have not even suspected. As surprising as it may seem, the full truth is that even the conventional special literature does not cover all aspects that bear upon mankind's economic problem.

For a simple exposition of the basic thermodynamic laws, I shall use the image of Figure 2, p. 89, in which the hourglass represents an *isolated* system; i.e., a system which can exchange neither energy nor matter with the outside.¹¹ (Besides the whole universe, only some laboratory apparatuses correspond, but only approximately, to this last condition.)¹² If the stuff inside the hourglass represents matter-energy, the simple fact that the hourglass is completely sealed expresses the First Law of Thermodynamics, the Conservation of Matter-Energy. As in any hourglass, in the universe hourglass the stuff continuously pours down from the upper into the lower half. However, two important features distinguish the universe hourglass from an ordinary one.

First, as the stuff matter-energy pours down, it changes its *quality*. As long as it is in the upper half, it represents *available* matter-energy—that is, matter-energy in a form that can be used by us, human beings, as well as by any living organism of the kind existing on this planet. When it reaches the lower half, the available matter-energy loses its important property; it becomes *unavailable*.

The *second* difference is that the universe hourglass cannot be turned upside down, which means that *the available matter-energy of an isolated system is continuously and irrevocably degraded into the unavailable state*. And if we are reminded that the involved concept of "entropy" is, at bottom, a relative index of the amount of unavailable energy, the last statement constitutes a simpler as well as more telling formulation of the Second Law of Thermodynamics, the Entropy Law, than that found in the special literature.¹³ There we read that the entropy of an isolated system constantly increases.

There are two other laws, the Zeroth Law and the Third Law. Suffice here to recall that the Third Law says that no hourglass with a completely empty lower half can be obtained. Instead, other points must be borne in mind in order to avoid the numerous pitfalls in this field.

¹¹ Georgescu-Roegen (1975a), (1975b), (1976a), (1976b).

¹² Think of the astronomically immense waves of neutrinos that pass without any difficulty straight through the Earth's mass.

¹³ A crucial point omitted by this literature is that the degradation parallels the stream of our consciousness. Without this clarification, "increase in time" has no operationality. It is curious, therefore, to hear often that thermodynamic does not involve time at all. This is true only for the fiction of reversible cycles, with which instruction starts in all manuals (and to which I shall come back). The truth is that it was in thermodynamics that time first entered with its unique characteristic—irreversibility. All laws of mechanics are indifferent to the sign of the time parameter. Georgescu-Roegen (1966), (1971).

One such point is that the Entropy Law, in contrast with all other laws of physics and chemistry, leaves the speed of the degradation *and* the structure of the outcome completely indeterminate. It is because of this indeterminacy that the presence of life matters entropically. If solar radiation strikes a bare rock, it immediately degrades into dissipated heat, into unavailable energy. But if it strikes a green plant, part of it is stored up as chemical energy. In the long run, however, even this stored-up energy must turn into dissipated heat. A pile of coal left by itself begins to radiate heat and "sweats" (because the involved chemical reduction produces, among other things, H₂O). In contrast with the green plants, all other forms of life—consumers, predators, and decomposers—speed up the entropic degradation. It is, moreover, because of the same entropic indeterminacy that life can exist in the multifarious forms we know and we can make plans of all sorts and expect to fulfill them.¹⁴

Considered as an isolated system, any organisms must degrade entropically; in the end, it dies if isolated from the environment. What causes an organism to survive in spite of its entropic degradation is the fact that it can suck available matter-energy from the environment and expel into the same environment its produced unavailable matter-energy, its wastes. This is exactly what the economic process does in order to maintain in good functioning order the endosomatic structures of people (their bodies) as well as their exosomatic organs (which economists call capital equipment). Naturally, this is only the material side of the story. It would be absurd to say that the economic process merely taps valuable environmental resources only to transform them into waste. The true product of that process is not a material flow, but an immaterial flux: the enjoyment of life. An entropic feeling of this sort must exist even in the lowest organisms proper.¹⁵

The economic process is, therefore, entropic, not mechanical. And because the Entropy Law dominates all material transformations associated with it—with life, in general—that process marches on in an irrevocable way. The depletion of resources cannot be reserved, and some waste remains waste. In this simple proposition lies the root of ecological scarcity viewed in an embracing ecological perspective.

III. THE NECESSARY DUALISM: ENERGY AND MATTER

In the literature, the scarcity problem has constantly been reduced to the supply of available energy alone. The concept of net energy, thought up by Fred Cottrell (1955) for analyzing the economic activity of production, has recently been revived by H. T. Odum (1973) as the only criterion for entropic efficiency. Certainly, because we can always compute differences of the same homogeneous entity, there is nothing wrong in saying that if one ton of oil is used in obtaining ten tons of oil from some shale the result is a net energy of nine tons of oil. But this way of keeping entropic books ignores that for whatever we do we must see *both* energy and matter. Therefore, according to the Cottrell-Odum conception, the result of a copper mining opera-

¹⁴ Georgescu-Roegen (1971).

¹⁵ Georgescu-Roegen (1971).

tion ought to be described as a fantastic *negative* net energy. In fact, that operation produces a large positive *net matter* of copper and a negative net matter of other materials. Extracting oil from some good shale produces not only some positive net energy but an immense positive net matter of crushed rock (which we would rather not have). It is thus clear that the problem of entropic bookkeeping is not as simple as we have been led to believe.

In contrast with the conventional literature, which speaks only of energy, in the foregoing discussion of the thermodynamic laws I have continuously spoken of matter-energy. The conventional literature not only leaves out some essential phenomena characteristic of matter, but it also marshals the exposition in a way that tends to deny their existence.

In the introductory chapters of the usual thermodynamic manuals we are taught that, if the internal energy of a *closed* system remains constant,¹⁶ then the energy received from or transferred to the outside is equal to the work performed by the system or on the system, respectively.¹⁷ This theorem has a historically momentous corollary: perpetual motion of the first kind (work without energy) is impossible. Let us note, however, that on the basis of this restriction alone all material systems may be reversible, for the theorem does not deny the possibility of converting some energy into work and that work back into the exact initial amount of energy. This means that perpetual motion of the second kind—a motion which goes forever on a finite amount of energy—is possible. Just an ounce of gasoline—actually, even one millionth of an ounce—would then suffice to drive an automobile forever. There would be no need for continuously tapping the terrestrial deposits, except for growth (which may mean more people or more automobiles).

However, a somewhat side thought is added to the argument of this particular topic in the conventional manuals. To be completely reversible, as implied by the cyclic conversion between energy and work, a system must move with *an infinitely slow speed*.¹⁸ The obvious, but rarely noticed conclusion of this amendment is that even a small movement must take an infinite time. This result should suffice by itself to establish the factual impossibility of reversible systems, hence, of a world in which the need for additional energy is occasioned only by growth.

The curious fact is that the real reason for requiring that the speed be infinitely slow is never revealed in pointed fashion. This reason is that with an infinitely slow speed there can be no friction. Friction is a rather poorly understood phenomenon, but it is ubiquitous in the material world of solids and fluids. A single crystal moving in a perfect vacuum does not produce any friction. Even in the few manuals which in the subsequent chapters tell us that not all energy can be converted into *effective* work—part of it being always converted into

¹⁶ A closed system can exchange energy but no matter with the outside. To a good approximation, the Earth represents such a system. A system that can exchange both energy and matter with the outside (like an organism or like the ongoing economic process) is *open*.

¹⁷ E.g., Max Planck (1945).

¹⁸ Planck (1945), p. 53.

work against friction—is the absence of friction connected with the condition of infinitely slow motion.¹⁹

On the surface, there appears to be two phenomena that continuously rob us of available energy: dissipation of thermal energy (heat) and friction. They boil down to the dissipation of available energy because friction only causes an additional dissipation. What is not generally realized is that in the actual world available matter also dissipates continuously and irrevocably into unavailable matter. Matter also becomes increasingly diffused. And, as any automobile driver knows from everyday experience, friction causes not only an additional loss of available energy, but also an additional dissipation of matter. Otherwise, automobile tires would last forever.

Because of this symmetry between matter and energy, from my earliest endeavors in this direction I have insisted that both these elements of the physical world continuously degrade into unavailable forms.²⁰ The essence of the Entropy Law is that the entropy of both energy and matter continuously and irrevocably increases. For this formulation, we need to recall that entropy is a relative index of the nonavailability of matter-energy in “sizeable” structures.

This position is vindicated by a discovery made by J. Willard Gibbs one hundred years ago.²¹ The discovery is rarely mentioned in the usual literature. And, when it is mentioned, it is presented as the Gibbs paradox, because what Gibbs discovered is that entropy increases also when matter becomes dissipated, specifically, when two *different* gases interfuse. This practice is indicative of the widespread position that only energy counts and only energy must, therefore, be included in a thermodynamic framework. Gibbs himself was at a loss for a clear explanation. But a hint—perhaps, the only one—that the entropy increase discovered by Gibbs corresponds rather to “a dissipation of matter than [to] a dissipation of energy” was made years later by another giant of physics, Max Planck, in his *Treatise on Thermodynamics* (originally published in 1897).

Compare the available chemical energy concentrated in a piece of coal with the dissipated heat (unavailable energy) into which it is converted by burning. Compare also the copper molecules concentrated in a newly-minted penny with part of the same molecules scattered to the four winds as the penny wears out by friction. In this perspective, we can say that low entropy of *both energy and matter can be used only once*.²²

One is apt to interject at this juncture that the equivalence between work and energy proves that any job can be done provided the supply of available energy is sufficiently large. With sufficient available energy we are able to reconcentrate the dissipated energy of a glass of water so as to have again some ice cubes in it. By the same token, we ought to be able to reassemble the scattered copper molecules of a worn out penny. Would anyone deny that, if a necklace breaks and its pearls are

¹⁹ R. S. Silver (1971) is probably the first manual in which work is, from the outset, separated into *effective work* and *work against friction*. But even that author misses the connection mentioned here, which is so clearly seen in the simple fact that, *ceteris paribus*, the greater the speed, the greater the friction.

²⁰ Georgescu-Roegen (1966), (1971), and chapter I (1976).

²¹ J. Willard Gibbs (1875–1877).

²² Georgescu-Roegen (1966, p. 94). (1971, p. 278).

scattered all over the floor, with some energy and the wearing out of some material objects we are able to pick up all of after some *finite time*? But let us imagine that the same pearls are dissolved into some acid and the solution is spread over land and sea. (Something of the sort would in fact happen after the complete wearing out of the pearls.) The point is that to reassemble the pearls in this last case would take a *practically infinite time*. For this reason—the same as that which makes frictionless motion and reversible systems impossible in actuality—we must reject the notion of complete recycling, a notion which now forms the basis of numberless schemes of resource savings. To be sure, we can recycle, but only available matter that is no longer in a shape or a state *useful* to us. We can recycle only what I have called “garbojunk”—broken glass, used metal cans, old motors, etc.²³

It is a mistake (though a popular one) to extrapolate molar operations, picking up sizeable pearls—to the molecular level—reassembling the dispersed molecules of the same pearls. There is here a dialectical threshold, similar to that pertaining to very small or very large probabilities or to small or large biological mutations. Although we can reassemble the copper molecules contained in an ordinary copper ore, the same operation is unavailing if the metal concentration is so low that it represents unavailable matter. Moreover, even after concentrating the copper from some good ore into a copper sheet, one should not exclaim “Lo! I succeeded in decreasing the entropy.” For in producing the copper sheet, the entropy of the rest of the isolated system (practically, the accessible environment) has been increased by more than the decrease from the copper ore to that sheet. The entropy of the entire system must increase, as the Entropy Law says. Economists have long since preached that “there is no such thing as a free lunch,” by which they meant that each lunch must be paid its economic cost. From what we have seen above, the ecological predicament is harsher: in entropic terms, for every lunch, we pay more than the lunch represents.²⁴

There remains one final suggestion to be probed. It stems from the familiar Einsteinian formula $E=mc^2$. This means that we ought to be able to obtain by conversion as much matter as we please if we control a sufficiently large supply of available energy. The snag of this solution is that the Einsteinian equivalence works primarily in the conversion of matter into energy, as is the case of all stars as well as of anything we burn, whether ordinary or nuclear fuel.²⁵ Matter may be formed from energy *and* matter, but not from energy alone,

²³ Georgescu-Roegen (1975b), (1976a), (1976b). In connection with this point, it seems necessary that I should not ignore a technical issue. Schemes by which a mixture of two different gases can be again separated appear now and then in the literature. They are based on perfect semi-permeable membranes (i.e., membranes that each allow only one of the gases to pass through). However, as Max Planck (1945, pp. 210, 233) demonstrated, no perfect semi-permeable membrane exists in actuality. We are here again confronted with still another difference between conceptual and actual.

²⁴ Barry Commoner (1971, p. 45) was, therefore, in substantial error to dress up the economists' slogan as the fourth law of ecology. That slogan expressed only the impossibility of the perpetual motion of the first kind; economists have never taken account of the Second Law.

²⁵ The loss of mass in conversion is hardly measurable for ordinary fuels—a small fraction of one percent for dynamite, but about one percent for plutonium. At the sun's size, the loss becomes staggering: four million tons of mass per second!

not even in the stars, where conditions may seem more favorable for the fusion of *massless* particles.²⁶

Certainly, because of the entropic degradation which in this case exists even at the nuclear level, the radioactive elements are no longer in the same amount nowadays as at the formation of the earth; the same is true for their decay products. But, the amounts of stable elements, such as copper, iron, tin, etc., have remained constant through out.²⁷

The conclusion of the arguments developed in this section is that we cannot avoid the necessity of keeping books in terms of energy *and* matter. The ecological problem cannot be reduced only to net energy, not even to net energy and net matter in separation. There is only *global* accessibility, which is the essential property of a hospitable environment vis-a-vis a given technology (or biological mode of life). Moreover, because of the practical impossibility of the alchemy of most chemical elements, the ecological books must distinguish even between the various basic elements.

Still another important consequence follows from the fact that matter and energy cannot be reduced to a practical common denominator. If everything else is left aside, we cannot decide which of two processes serving the same purpose is the more efficient—that which uses less matter and more energy or that which uses more matter and less energy. This decision remains an economic one because it must take into account the relative supplies of the ingredients.

This is still not the full cup. Because the economic process is anchored in the material environment, we are completely justified to say that its nature is entropic. However, this should not be interpreted as meaning that economic value can be reduced to some physical coordinate. This would not be possible even if there were a common denominator for energy and matter. For in the cost of things there enters also the drudgery of work, which is another immaterial flux that cannot be deduced from the physico-chemical laws and which is part of man's scale of values. As the long forgotten axiom of Sir William Petty states, nature is the mother of economic value and labor the father.

IV. THE GENERAL FLOW MATRIX OF THE ECONOMIC PROCESS

As noted earlier, the only purpose of the economic process is to maintain its fund elements—the people and their exosomatic instruments—in their proper state of good function. To be sure, what state is the *proper* one depends on the social organization, the scale of values, and the technological horizon at that moment. But whatever this state may be, the funds are subject to the general entropic degradation. All around us there is friction, chipping, cracking, spontane-

²⁶ The origin of chemical elements in the universe is still an unsettled issue, but the issue turns only on whether the original basis included helium (in addition to hydrogen). Hydrogen "burns" into helium at a temperature between 10^7 and $2 \cdot 10^8$ degrees centigrade. Helium burns into carbon at a temperature between 10^8 and $2 \cdot 10^9$. Heavier elements are produced at still higher temperatures; but at $4 \cdot 10^9$ degrees centigrade, equilibrium between light and heavy elements is reached.

²⁷ To be correct, one should take into account the meteorite fall and the particles which occasionally may escape the gravitational pull. The meteorite fall, although of appreciable weight (150,000 tons per year), does not count practically; it comes mostly in the unavailable state.

ous combustion of various degrees, washing and blowing away, and so on.

But we must also observe that the entropic degradation associated with the economic process is not due solely to these entropy producing phenomena. The green plants expected, all organisms produce some additional entropy. However, none matches the scale of man's production of extra entropy. If a tree is left in the woods, it will die, then rot, and ultimately part of it will be blown or washed away, or burned by spontaneous consumption. But if a tree is cut down and burned in a stove or a furnace far away from the forest, an amount of entropic degradation which otherwise would have taken eons to produce is effected in a short interval. The same applies to the growing of food on farms and eating it in far away urban agglomerations. Facts such as these seem to be completely ignored by those who place in front of our eyes some highly attractive visions of almost self-contained New Jerusalems on desert lands or those who try to lull us into believing that matter does not count.²⁸

It is not only for supporting a growth of the fund elements, but for simply balancing the entropic degradation of the existing funds that the economic process must continuously draw from the environment a flow of low entropy consisting of both energy and matter. From the argument of the preceding section it follows—a point worthy of strong emphasis—that an input flow of available matter would be absolutely necessary even if the economic process were stationary—i.e., if it did the same thing day after day, hour after hour.

The input flows consist of energy and matter *in situ*—i.e., of environmental energy and matter—to be denoted in our matrix by eE and eM , respectively. (See Figure 3, p. 89.) Two distinct activities take care of transforming the eE and eM into controlled energy and matter, E and M , respectively. Any mining and, if that is the case, any associated refining activity belongs to this category. The economic process further includes the familiar activities, the industry of capital goods, K , the industry of consumer goods, C , and the household sector, Hh .

For the ecological analysis, we must also set two new activities in a separate manner. They are the recycling activity, R , and the depolluting activity, Dp . The first activity recycles all recyclable garbojunk, rGJ , produced by *all* other sectors. (It may safely be assumed that R produces no garbojunk.) The depolluting activity only renders less harmful that waste, w , produced by the others sectors and capable of being so changed. Absolutely all sectors produce some w . And absolutely all sectors produce some final outflows into the environment which consist of dissipated energy, dE ; dissipated matter, dM ; and final waste, W , waste that cannot be (or is not) reduced or changed by Dp .²⁹

In Figure 3, p. 89, the thin arrows show the flows between the sectors of the economic process. For the ecological problem, only the flows between that process and the environment (represented by thick, shaded

²⁸ E.g., Roger Revelle (1975); and H. E. Goeller and Alvin Weinberg (1976).

²⁹ Some of the activities distinguished in our matrix are not performed separately from each other in actuality. A coal burning furnace would have a sulphur trap embodied in itself, for example. The separation adopted above facilitates, however, the analytical portrait.

arrows) count. The picture tells us a few elementary points. The first is that recycling, besides not being complete—a great deal of available matter ends up either as dissipated matter or as final waste—is not free either; it “costs” some additional environmental low entropy as well as some additional labor services.³⁰ The same is true of depolluting. Second, the “bigger and better” the automobiles, the refrigerators, the jet planes, etc., the bigger and better are the depletion of natural resources and the untreatable (or untreated) waste. But the general flow matrix of Figure 3, p. 89, teaches us also an important lesson which is not only completely novel (as I believe) but also exposes a widespread fallacy about mankind’s problem crystallized in the slogan “come what may, we shall find a way.”

V. THE ABC OF BIOECONOMICS³¹

This ABC may begin with the probing of an idea set forth more than one hundred years ago by John Stuart Mill (1848) and recently revised and bolstered by a few writers, in the most persuasive manner by Kenneth E. Boulding (1966) and Herman E. Daly (1971). The quintessence of the thesis is that ecological salvation lies in a stationary (also called steady) state. Daly (1971, p. 5) even argues that “the stationary state economy is . . . a necessity.” The notion of a stationary state was best described by Karl Marx, who used for it the term “re-producible”. Indeed, whenever this notion is encountered in the literature, in the ultimate analysis it denotes a system which remains identical to itself in a specific way: the population of its fund elements—that is, the *matter* scaffold of the system—must remain constant. To be sure, Mill’s revised theme also specifies that population and capital equipment—the material funds of the economic process—are to remain constant in the stationary state.³²

Now, from what the Entropy Law teaches us, an *isolated* system cannot be a steady state unless it has already reached its maximum entropy, at which stage both its matter and energy are completely dissipated. Such a system is a state best described as chaos, in which no work of any kind can be performed any more. The elementary conclusion is that a “living” stationary state cannot be isolated. It could be either *open* or *closed*.³³

The case of the open steady state has formed the object of special studies initiated by I. Prigogine (1967) on the basis of some famous equalities established by L. Onsager in 1931.³⁴ The interest in this kind of system stemmed from its analogy with living organisms, which all *tend* to maintain their individual entropic structures constant. Their partial success is due to the fact that they can exchange both matter and energy with the outside. Their ultimate failure reflects the fact that stationariness requires that Onsager’s equalities—which corre-

³⁰ To keep the graph as simple as possible, the funds associated with each activity (which consist of the three classical factors of production—labor power, capital proper, and Ricardian land) have not been represented in Figure 3, p. 89. This does not mean that we may lose sight of their existence.

³¹ See Georgescu-Roegen (1976), chapter I, and the forthcoming volume *Bioeconomics* (Princeton University, 1977) by the same author.

³² Daly, 1971 (pp. 10, 12).

³³ See note, p. 12.

³⁴ A systematic presentation of these results is supplied by Katchalsky and Curran (1965).

spond to a detailed balance of the flow elements—be satisfied *exactly*. No actual system, however, can satisfy such a detailed, rather *delicate*, balance exactly. Yet, a stationary economic process may conceivably exist provided that the input environmental flows, eE and eM , and the output flows, dE , dM , W , could be maintained constant and, in addition, be in complete balance as regards energy and matter. Actually, some past economic systems and even some contemporary ones may well seem to be steady. The most salient case is the economy of the traditional village, which has survived over the longest period in history so far. If such economies may seem steady, it is only because of their extremely slow consumption of mineral resources and their low population density relative to the available productive land. However, even in the absence of any population increase, the departure from stationariness must, in the end, show itself up in more than one way. Without outside compensation for the inevitable entropic degradation, any topsoil ultimately will degrade. An industrial society as fervent as that prevailing in most parts of the world today could hardly appear as a steady process. No coal or iron ore is available at a quasi-constant flow rate over some relevant period if the productive agents remain constant. Sooner or later—rather sooner than later—we have to dig deeper or turn to poorer lodes. Hence, either the environmental input flow rate must decrease or the exosomatic instruments must become more efficient by some innovation. And there is no guarantee whatsoever that they could become so at just the right moment, not later, and not sooner either. In any of these cases, the system ceases to be stationary.

The conclusion is inescapable. Stationariness per se is not part of mankind's lot. What counts, as I shall explain presently in greater detail, is the economy of resources, not for only one generation (as in the narrow horizon of standard economies), but for all generations, or at least for as many generations as possible. If the prescription of stationariness appeals, however, as it does, it is because of a peculiar error of logic. Since growth is wrong ecologically—as by now only a few doubt it—no-growth became equated with stationariness. In fact, decrease appears to be the right prescription in some parts even today, in all parts in the long run and on the average.³⁵

One particular condition of our planet (and, in all probability, for any other possible planet inhabited by some form of life) has an important bearing upon the theme of the steady-state economy and also upon our understanding of environmental economics. The earth, taken by itself, is not an isolated system, nor is it an open system. For all practical purposes, the earth is a closed system; it exchanges only energy with outer space.³⁶ This simple observation suffices to bring up the idea that, our present hustle and bustle with the energy crisis notwithstanding, matter will ultimately prove to be the most critical factor of the environmental dowry.³⁷

Mankind's dowry of accessible low entropy consists of three distinct items: (1) the *flow* of solar energy which reaches the upper fringes of the earth's atmosphere at the rate of 1000 per week (where Q is an

³⁵ Georgescu-Roegen (1976), chapter I.

³⁶ Cf. note on p. 71.

³⁷ See the author's 1972 lecture at Yale University in Georgescu-Roegen (1976), chapter I.

astronomical unit of thermal energy, $Q=10^{18}$ BTU); (2) the *stock* of available and accessible terrestrial energy, consisting of fossil and nuclear fuels as well as geothermal energy; (3) the *stock* of accessible material low entropy.

Between solar radiation and terrestrial energy there exist several important asymmetries. We do not have and, almost certainly, will never have any control over the flow rate of solar radiation. For all practical purposes, this rate is a cosmical constant. Since we cannot mine the sun, no generation can deprive future generations of their share of sunlight.³⁸ By contrast, one generation may conceivably burn all the fossil fuel within just a few years, thus depriving all future generations of that source of energy. Solar energy does not pose a problem of intergenerational economics, whereas terrestrial energy, as well as terrestrial matter, does.³⁹ The coal consumed by us today is no longer available to any future generation. And every Cadillac, Rolls Royce, or Volga of produced for our present extravaganza means fewer plowshares for some future generations. Worse still, instead of forging our weapons into plowshares, as the famous saying invites us, are now forging future plowshares into weapons.

The second asymmetry is the relative dimensions of the two sources. According to the most optimistic estimations, the stock of fossil fuels amounts to only 200Q—that is, to only two weeks of sunlight! The same is true of fissionable nuclear fuels, if used in the ordinary reactor.⁴⁰ By contrast, the sun will shine with practically the same intensity for at least another four billion years.⁴¹ The sun is, therefore, one hundred billion times a greater mine than all fossil fuel reserves. So the latter energy is a scarce factor; solar energy instead fits the notion of a free commodity perfectly.

A crucial asymmetry is caused by the exceptionally low intensity of the ultra-abundant solar radiation. Its annual flow over the whole earth is no less than twenty-five thousand times greater than all the energy consumed now by the entire world, but it reaches us as an extremely fine mist.⁴² Let us think of such fine rain mist, instead. We certainly could convert the kinetic energy of its billions of billions of droplets into useful mechanical work by catching them on a very large solid plate. That energy could conceivably crush a metropolis if the plate were large enough. However, we do need to do so. Rain, even as a mist, accumulates by itself into streams, creeks, and rivers, so that we only need to place a turbine where the raindrops have accumulated in a propitious manner. The immense drawback of solar energy is that it does not accumulate by itself. We must use an immense plate if we want to harness it directly.

This means that catching solar radiation directly in concentrations as great as those supplied by terrestrial fuels we must use a relatively

³⁸ It could, of course, deprive future generations of the natural benefit from solar radiation, say, by excessive deforestation.

³⁹ Georgescu-Roegen (1975a), 1975b), (1976), chapter I.

⁴⁰ With the help of the breeder, which converts fertile fuels, too, into thermal energy, the picture is greatly, but not essentially, changed. It includes, instead, biological as well as social incommensurable risks.

⁴¹ For still another instructive comparison, we should note that the present annual rate of energy of all kinds used in the world amounts to only 0.2Q.

⁴² One should not wish it to be more intense, for no life would then be possible. Both too little and too much entropy is incompatible with the terrestrial form of life, at least with the human one.

greater amount of matter. How much greater this disproportion may be is indicated by the fact that the installation recently inaugurated by ERDA at an Atlanta elementary school (which could not be too large) cost nearly one million dollars, although it supplies only sixty per cent of the power needed for heating and cooling. Even though prices are parochial (in a sense I shall explain in the next section), the cost is definitely impressive.

The same point, that a disproportionately great amount of matter is needed for the corresponding installations, may constitute the main obstacle to the development of other sources of energy, not only of the direct use of solar radiation. The unsuspected rise in the cost of nuclear reactors tends to support this view. Let us also bear in mind that the accelerator at Fermilab, for example, has a diameter of one and one quarter mile and involves nearly one thousand giant magnets. As concerns the fission reactor, no one can at present have any idea about what kind of colossus it will be, if and when it becomes an operational device.⁴³

The present generations are fortunate to live in a phase of mankind's exosomatic evolution when we still can tap the environment for available matter, eM. But assume that eM is eliminated from our general flow matrix. Since at least the outflow of dissipated matter must continue to result from the thermodynamic transformations within the economic process, the inevitable conclusion is that this process cannot persist only on an input flow of available energy. If the idea that we need not worry about the supply of available matter has a large currency nowadays, it is only because we still live in a period of mineralogical bonanza. It is only because of this bonanza that one can speak of unlimited substantibility and still be believed.⁴⁴ However, given that the earth is a closed system, in the long run matter is a more vital item than energy—a lesson we have learned from Section III.⁴⁵ This point is the last straw—if such a straw be needed—to break the back of the stationary state thesis.

Given that mankind's exosomatic existence is an irrevocable fact, the scarcity of energy from terrestrial resources—the only energy that seems capable of the intensity required by industrial activity—also matters greatly. It is, therefore, the amount of terrestrial resources that determines the possible life span of the human species. That exact amount may not be known, now or in the future, but it undoubtedly is finite. And being finite, it sets an upper bound to the "amount of life" of the human species measured in man-years. The actual amount of life depends, in addition, on the speed with which those resources are used up. It becomes greater or smaller according to whether that speed is faster or slower.⁴⁶

The upshot is that, in the ultimate analysis, the economy of resources hinges mainly on demand. Demand simply constitutes the

⁴³ Georgescu-Roegen (1976a). In judging the value of any new achievement, we must also distinguish between experiment and effective operationality. In an experiment the magnitude of the cost does not matter: all that matters is the realization of some idea and what we might learn from it. Think of the man put on the moon.

⁴⁴ Goeller and Weinberg (1976).

⁴⁵ In fact, one can prove a proposition that may be presented as the Fourth Law of Thermodynamics: the material entropy of a closed system tends to a maximum. Georgescu-Roegen (1976a), (1976b).

⁴⁶ Georgescu-Roegen (1970), (1971), (1976), chapter I.

most direct and the surest element for action in this respect. When things become increasingly scarcer, we must do with less. This truth is so old that it is highly surprising to have to remind ourselves of it.⁴⁷

In emphasizing the role of demand in the economy of natural resources, I do not mean by any twist of the language that we should not strive to discover more efficient techniques for using environmental low entropy, that is, to increase either the supply from the constant stock of terrestrial resources or the effective use of solar radiation flow. What I claim—and claim must—is that to speak *only* and in an extolling manner of such probable techniques before they are actually discovered is to lull us into a dangerously soft attitude.

One can hardly think of a more unwise advice for the human species as a whole than that propounded by some economists and even by a few scientists: “come what may, we shall find a way.”⁴⁸ From the undeniable historical fact that ever since the time of Pericles (and even earlier than that) man has been able to discover new sources of low entropy and new ways of using them, it does not necessarily follow that this feat will necessarily go on forever within a finite environment. For equally undeniable is another historical fact, namely, that in numberless places on the earth oil wells and other mines did become dry, so dry that no technique could possibly continue to get anything out of them. The history of the earth, moreover, teaches us that a legion of biological species have become extinct even though at one time they were thriving without any difficulty in sight. The dinosaurs, for example, disappeared after more than one million years of solid existence. True, they were not intelligent beings. But, on the other hand, they were not addicted to terrestrial resources and, hence, produced no industrial pollution.

As terrestrial resources become inevitably scarce (because of the continuous and irrevocable transformation of eE and eM and dE, dM, and W), to “find a way” becomes increasingly more urgent and more difficult. The task is now extremely urgent because of the complications by the population explosion. But even with a stationary population, any delay in discovering a new way increases the probability of an ecological crisis—after which any technological innovation would come too late. The task becomes increasingly more difficult because, first, even the efficiency of any legal transformation of energy into useful work as a theoretical limit smaller than one hundred per cent, and second even this theoretical limit cannot by far be attained because of friction, diffusion, and imperfect burning. Progress in increasing the efficiency of actual transformations has been notoriously slow, the landslide of technological innovations of the modern era notwithstanding. Certainly, the stepping stones of technological progress are provided by the discoveries of how to do either new things or the “same” thing in a new way. However, in contemplating the technological progress of the last one hundred years or so, we should not ignore the important role played by the mineralogical bonanza that has accompanied it. Whether without this bo-

⁴⁷ According to one recent presentation by a representative of ERDA (at the symposium on Renewable Energy Resources, May 17, 1976, in New York), the strategy of that agency completely ignores “to do with less.” It is either imminent entropic bankruptcy or Project Independence.

⁴⁸ See especially Wilfred Beckerman (1972) and John Maddox (1972).

nanza the technological process would have been just as spectacular is a moot question and may remain so forever. The pawns of history cannot be rearranged as in chess, in order to find out what might have happened otherwise.

Surprising though it may seem, especially for the worshipers of technology, the spectacular technological progress of the recent past has, more often than not, represented a move against the economy of resources. A good example is the progress of how to detect new mineral deposits. The more easily these deposits could be discovered, the more energy other innovations have been free to squander. Witness not only the automatic drive, the rolling concourses, the flagpoles operated by electronic eyes, etc., but also the passage from the horsecart and the bicycle to the Concorde airplane. However, the most salient, albeit the most ignored, transgression in this respect is that of mechanized agriculture and the high-yield varieties which nevertheless earned their discoverer a Nobel prize. Mechanized agriculture means a substitution of a scarce resource (terrestrial energy) for a free one (solar radiation) and an increased depletion of mineral deposits. This is indeed the result of using tractors instead of draft animals, gasoline instead of fodder, and chemical fertilizers instead of manure and fallowing. High-yield varieties, which depend on all this, cause an additional squandering because for the same amount of crop they consume about three times as much chemical fertilizer as the ordinary varieties. Yet both mechanized agriculture and high-yield varieties are an imperative practice nowadays. The only way to support a large and growing world population is to increase the yield per acre at any cost.

The theorem is analogous to an engineering one, which though a commonplace, is totally ignored by all rationalizations of thermodynamic phenomena. The engineering theorem says that the average energy per kilogram necessary to set a weight in motion increases, *ceteris paribus*, with the weight. Similarly, the average cost in low entropy for the maintenance of an individual increases, *ceteris paribus*, with the size of the world population. To wit, in principle the organic capacity of the earth may be able to maintain a population of one billion, perhaps even over four billion years, but certainly not one of four hundred billion over ten million years, although both situations represent the same amount of life in man-years.

VI. BIOECONOMICS AND ECONOMICS

A minimal bioeconomic program emerges irrepressibly from the thoughts and facts presented in the foregoing pages.

Perhaps the most obvious commandment of all is not only "to beat our swords into plowshares"—as the unheeded biblical call says—but, even more important, to completely stop forging any future plowshares into present weapons. The destiny of the human species is not helped much if only the waging of war is outlawed, while the production of armaments is not. In addition to the danger that someday the weapons will have the better of people, one must think of how much hunger and misery could be stamped out instead.

Second, the world population must be brought down to the level of the present organic carrying capacity of the earth and be main-

tained at the compatible level with any change of that capacity.⁴⁹ This is the only sound basis for defining optimal population.⁵⁰ In the very long run, population must come down to the optimal level, whether or not we do anything about it; but it is far preferable not to let the reactions occur by themselves (if we can).

Also, there will necessarily occur a large degree of deurbanization, since organic agriculture requires that man share the land with his working partner, the beast of burden, which needs fodder. An immense additional amount of low entropy will be saved because of the implicit reduction of transportation.

But the issue of population pressure cannot be separated from that of the prevailing exosomatic inequality between the advanced and the underdeveloped nations. The hungry masses are no longer isolated from the oversaturated. They are in their right to demand a proportionate share of mankind's welfare. This demand, together with the fact that many underdeveloped nations happen to possess large and vital mineral resources, sets the stage for an explosion of the conflict between superpowers, which at the advanced technology of superdestruction can have only incalculable consequences. The advanced nations, if they were the enlightened leaders they claim they are, must see to it that the underdeveloped is gradually and soundly helped toward progress—not, however, the progress envisioned by the growthmania spread all over the world by the standard theory of economic growth.

As I have argued earlier, we must also slow down demand, especially in the most advanced countries. The have-nots are right in pointing out that one new member of these countries degrades about one hundred times as much, if not much more, low entropy as one member of the least fortunate nations. Still more saddening is that in the advanced nations consumption consists in a large measure of utterly flimsy, even absurd, items—splendidly illustrated by the golf-cart, the two-garage car, or the “latest” fashion of clothes and furniture. To get rid of our craving for mammoth or futile gadgetry and to cure ourselves of that disease of the human man, as Abbot Fernando Galiani qualified our love for fashion, require some change of values, which may be brought about in diverse manners. But once this change is accomplished, we can rest assured that all producers will follow suit in producing only unquestionably useful items, more durable and more easily repairable as well.

With the disappearance of the craving for the futile, mankind will *ipso facto* get rid of another ill, to which I referred as the circumdrome of the shaving machine.⁵¹ This is to try to shave faster so as to have more time to design a shaving machine that will shave faster so as to have more time to design a still faster shaving machine, and so on in an empty infinite regress. People of the industrially advanced countries

⁴⁹ By the *organic* carrying capacity it is meant the capacity to produce food and fodder only with natural means, without machinery, artificial fertilizers, etc.

⁵⁰ To ask only how large a population the earth could feed if every acre is cultivated according to the best-known techniques for maximizing the yield, without asking also how long such a population could survive, betrays a narrow and linear view of the issue—the view that what can be done once can be done again and again on end.

Let us also note that the stationary state thesis provides no criterion for the desirable size of population. Daly (1973, p. 154f).

⁵¹ Georgescu-Roegen (1976), chapter I.

seem to have lost the faculty of enjoying substantial leisure spent in intelligent fashion, although such leisure is one of the essential ingredients of "good life".

The minimal bioeconomic program should aim at minimizing the input flows eE and eM —for which Kenneth E. Boulding has coined the fitting term "through-put"—by still another way. Overheating, overcooling, overspeeding, overlighting, and all such overs must cease.

As the case of a stationary state (in which the environmental inflows and outflows balance out) proves, lowering the input flows by the various means described above necessarily lowers the outflow of global waste, composed of dE , dM , and W . However, the problem does not end here. With respect to pollution, quality, not only quantity, matters. Some pollution may be more harmful than another, even though it is produced in a far smaller quantity. Thermodynamics, which deals only with one qualitative distinction (that between available and unavailable energy), may explain why lead, for instance, increases the efficiency of gasoline, but it cannot explain why lead is a poisonous substance for humans and other biological organisms. The only explanation of this qualitative property of lead and numberless other substances comes from biochemistry, many only from biology or medical sciences. Because of this pronounced qualitative aspect, the problem of the optimal welfare for the entire human species becomes extremely involved.

There, are, however, a few things which no proposal for improving that welfare (which is tantamount to avoiding as much as possible ecological catastrophes) can ignore. The first is the general flow matrix, which, among other things, teaches us that the reduction of pollution is not free. As Harry G. Johnson (1973) noted in countering the environmentalist thesis, we certainly can reoxygenize a lake. But no economist's or engineer's magic wand alone can do it; the operation has a substantial cost in matter-energy. Moreover, the cost of reoxygenizing all dead lakes in the world may increase so much with the scale that the sacrifice may not be worth while. The saving alternative is to try to minimize polluting the lakes.

The second point to bear in mind is that depletion is irrevocable. On this point, too, we encounter some flights of fancy, such as that "with enough ingenuity" we could reconstruct the depleted mineral deposits.⁵² Ingenuity, of course, cannot create anything material from nothing. To recreate energy *in situ*, say, a coal mine, we would have to use some controlled energy. It would be absurd, however, to use such energy, for this purpose, instead of using it directly within the economic process. The circular operation would result in an unnecessary additional loss of accessible resources. And if one claims that with enough ingenuity we shall be able to convert *unavailable* into available matter-energy, one must believe in the possibility of refuting the Entropy Law. This means to devise a system which derives *unlimited* work from a *finite* amount of available energy.

Preoccupations with designing a perpetual motion of the first kind, once very fervent, were soon foiled. But those aimed at a perpetual

⁵² Harry G. Johnson (1973).

motion of the second kind lingered on. In 1883, J. Willard Gibbs deemed necessary to publish in *Science* a refutation of a claim published in the *Journal of Franklin Institute* concerning refrigeration without work.⁵³ Years later, Max Planck, in his *Treatise on Thermodynamics* (pp. 105f), criticized the position of those who claimed that the limitations set by the Entropy Law lie in the observer, not in the material reality. Still later, another great thermodynamicist, P. W. Bridgman (1955), thought it necessary to write a lengthy article against the belief of some of his colleagues in a scheme that may permit them to fill their pockets with money by “bootlegging entropy.”

Man’s heart, however, is big enough to harbor any hopes of his controlling nature so as to make it do anything he might wish. If Nicholas P. Chopey, an editor of *Chemical Engineering*, still believes that the Entropy Law may be refuted one day,⁵⁴ we need not be surprised by the numberless anti-environmentalists who, albeit *sotto voce*, feel certain of such a victory. While history proves that laws have been refuted in the past, its evidence in support of the Entropy Law is just as impeccable as that for gravitation. Actually—a point that must not be overlooked in any discussion of this issue—to refute the Entropy Law implies to screen out gravitation, i.e., to cause weights to rise from the ground with less energy than the corresponding mechanical work achieved by the rising.

Finally, we must accept that pollution is, in an appreciable dose, both inevitable and irreducible. Any available energy converted for other purposes such as heating or lighting inevitably ends up as dissipated thermal energy. As long as the flow rate of this conversion remains constant at a low level, this dissipated heat poses no problem: the earth continues to be in thermodynamic equilibrium with outer space at a propitious average temperature. But if the same flow rate decreases or increases, the earth’s old thermodynamic equilibrium is disturbed. The earth cools or heats up, respectively, a fact that may not only change the old delicate balance of the general climate, but also increase the size of the ice caps or melt a large part of them. There is no way by which this thermal pollution may be reduced: there is no way to heat or to cool a planet from within, otherwise than to burn more energy in the first case and burn less in the second.

In an ideal experiment analyzed on paper, any other pollution can be reduced. Any chemical reaction can be reversed; and so can, in theory, any diffusion of matter. Any contrary to what one may be told nowadays, even the nuclear garbage could be reduced or disposed of definitely. On the surface, the reason why complete depollution is not possible may seem to be the immense cost of the operation. The real reason is the truth taught by our general flow matrix, namely, that the material degradation caused by mixing or spontaneous chemical reactions cannot be reduced in a closed system in perpetuum.

The question of how to go about minimizing the throughput and minimizing harmful pollution comes up inevitably now. After pollution has struck almost everybody on the face and after the oil embargo offered a preview of the times to come, standard economists

⁵³ J. Willard Gibbs, *Collected Works*, vol. I, p. 404f.

⁵⁴ Letter to Dr. Frederick Forscher.

have suddenly become aware of mankind's entropic problem and discovered that "actually, they have something important to say to the world".⁵⁵ What they have to say is that if prices are right, there is no squandering and no pollution.

The fundamental creed of this claim is that "resources [and pollution] are properly measured in economic, not physical, terms".⁵⁶ This may seem an innocuous statement. Its fallacy should, however, become obvious to any one on second thought. The ecological problem exists even for a species that does not live by the market mechanism. It is, however, this apparently innocuous statement that provides the stepping stone to the more stringent position, namely, that the price mechanism, if oiled here and there, can offset any shortages and, hence, preclude any ecological catastrophe.⁵⁷ This is indeed the greatest fallacy of the entire history of economic thought.

Prices cannot constitute, even with a large tolerance, proper ecological criteria. To begin with, prices are parochial coordinates of the economic process.⁵⁸ They depend on the taxation structure, on the income distribution, and on the distribution of natural resources. Think what the oil prices would be today if the oil reserves were more evenly distributed among nations. Think also what the price of caviar or of some other luxury would be if there were more millionaires in the world. Moreover, prices are not proportional to the amounts of low entropy of the corresponding objects as such or of the low entropy degraded and the pollution produced through their production. And yet it is only the low entropy and the pollution that count ecologically. The point that the market mechanism, if corrected for its many biases, results in an allocation not much remote from the optimal one (as defined in the standard theory) is beyond question. But what the standard position totally ignores in this connection is that market prices are the result of the play of demand and supply of the actual participants in each particular market. The market price could be relied upon to solve the ecological problem—of the allocation of mankind's dowry and of pollution production—only if all future generations also participated in the bidding. Since this is not possible, the market prices cannot serve as criterion of ecological values. It stands to reason that if in auctioning Leonardo's *Mona Lisa* only people with modest incomes were allowed to bid, the auction price could not represent the value of that painting for the entire society.⁵⁹

Standard economists are apt to retort—as they indeed have—that since people save for the future through the money market, the interest rate together with the price constellation of goods will lead to the right allocation between present and future generations. This argument, too, is unavailing. As is generally recognized, all decisions concerning saving do not have a longer horizon than one generation, that is, about thirty years at most. This algorithm from one generation to another cannot possibly avoid possible future crisis sufficiently well in

⁵⁵ Robert M. Solow (1973, p. 49f).

⁵⁶ Carl Kaysen (1972, p. 663). Also Harold J. Barnett and Chandler Morse (1963, p. 347).

⁵⁷ The evidence for this position is abundant: Barnett and Morse (1963, p. 240f); Beckerman (1972, p. 337f); Harry Johnson (1973); Kaysen (1972, pp. 663, 665); Solow (1974, p. 46f); Henry C. Wallich (1972).

⁵⁸ Georgescu-Roegen (1971), chapter I in (1976).

⁵⁹ Georgescu-Roegen (1976), chapter I.

advance to be of any use in solving the problem of intergenerational allocation. Think of a person who looks at a train coming out of a tunnel and who can see only one or two cars before they emerge from the dark; only when the last two cars appear in sight can that person know that there are no more cars. By that time, it will be too late.

With the recent debate on environmental issues, economists have turned to an old article by Harold Hotelling (1931), in which a solution of allocation of finite resources over time was offered under the familiar assumption concerning the discounting of future satisfactions. But an admirable mathematical piece though it was, Hotelling's article offers no guidance regarding the real problem. Discounting the future makes sense in the case of an individual, and, as W. Stanley Jevons (1871) argued, only because the individual is mortal. Because there is a probability that he may die in the following year he naturally prefers to "eat" more now and save "less" for the future. The reasoning is faultless, for if, say, one thousand persons of the same age saved according to this discounting rule, every survivor would enjoy a constant utility, year after year. The situation changes completely in the case of a nation and, especially, of the entire mankind. Since a nation and, even more so, mankind are practically immortal according to the "year from year" or even "century from century" death probability, discounting the future would lead to the wrong solution in their cases.

For mankind, the optimal allocation of resources must be made so that the entire dowry is divided between all generations in equal proportions. In the mathematical model, the quota of each year is determined by the ratio between the amount of the dowry and the amount of total life until the extinction of the species.⁶⁰ To be sure, we shall never know the exact amount of the dowry and, much less, the total future amount of human life. But the principle is the only one to guide us in this situation of a unique complexity.

The present practice, which is not essentially different from that recommended by future discounting, is to tap *now* the most easily accessible resources, thus leaving the more difficult (and, very probable, the scantier) for the future generations. This is the result of maximizing present satisfaction—the first article of standard faith. The alternative offered above is based on an entirely new principle. For quasi-immortal units (and often even for mortal individuals) the most rational action is to *minimize future regrets*, rather than maximize present satisfaction.

The conclusion of the foregoing observations is clear. The only control levers of any ecological policy are the environmental inflows and outflows. This means that we ought to set some quantitative restrictions on the flows of eE and eM, as well as on the level of harmful pollution in the global waste. To arrive at some reasonable limits will require a vast effort to establish industry by industry the needed flow of low entropy and the inevitable flow of pollution. Once these limits are set, we may let the market mechanism work out the optimal flow

⁶⁰ In economics, we have played with maximization formulae so freely that we have lost sight of maximization in corner situations. This is seen in the objection that, without discounting, the yearly allocation must be zero. The objection ignores the constraint stemming from the minimum of subsistence, which establishes a corner maximum.

matrix relating environmental inflows to outflows of waste. We should continue to use the price system as a basis for income redistribution through taxation (positive or negative). But it would be wrong to adopt any of the schemes now offered by standard economists in which prices are used to deter depletion or pollution. The reasons for this opposition are ample. The standard argument assumes that taxes are operating, i.e., they are not so high as to be completely prohibitive. (And if they are prohibitive, the measure would not differ from the straightforward regulations.)

First, since we cannot attribute any prices whatsoever to low entropy *in situ*, no price can reflect the entropically valid worth of a commodity. "Depleter pays" and "polluter pays" may raise no qualms with economists since to think in terms of prices is their second nature. It is beyond question, however, that since there is no way to produce resources or to reduce irreducible pollution both principles just mentioned are vacuous.

Second, history proves that prices have not been able to prevent many ecological offenses in the past. Forests have been destroyed precisely because the prices were "right". Some species are now being menaced with extinction precisely because the price of a cheetah fur, for instance, is just right. Also, it was because the market price of oil was just right relative to that of coal that the automobile industry turned to producing mammoth gasoline guzzlers, while coal technology lagged behind with poverty spread in the mining regions.⁶¹ Only quantitative regulations could stop—as they have done in the case of deforestation—ecological abuses pertaining to depletion or pollution.

Third, taxes on ecological offenses would discriminate in favor of those who can afford to pay them. The ineptitude of such a policy explodes without right of appeal if one thinks of deterring crime by a tax on crime. That will certainly make crime pay!

Finally, a minor, but by no means negligible objection, concerns the ultimate use of ecological taxes. Since the proceeds must in the end be returned to the people (by one means or another), part of them will end up, by direct or indirect ways, in the pockets of those who have paid the tax. To prove this point, analytical examples may be constructed to show that all proceeds may return only to those who pay the ecological tax—with no other effect than an increase in the velocity of money.

In a nutshell, economics does not offer the instrumental frame for dealing with the ecological issue, simply because the nature of this issue is entropic. Unless fused with ecology, economics remains a science of the welfare of a single generation or, what logically comes to the same thing, of the fiction of the stationary state. And just as no physicist should claim that he is at the same time a biologist (or feel abashed for not being one), economists should accept the brute fact that economics is not bioeconomics.

⁶¹ William H. Miernyk (1975), (1976).

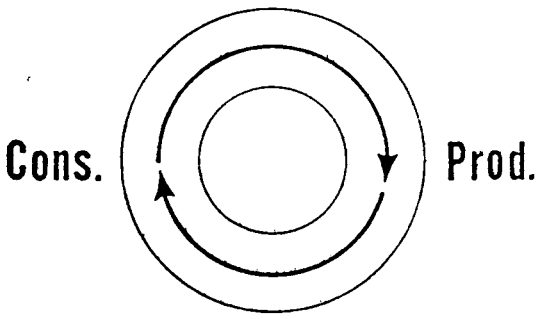


Fig. 1

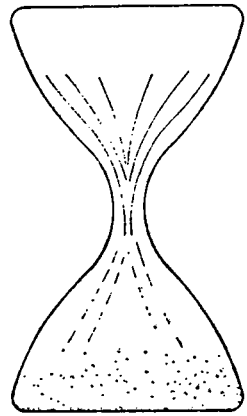


Fig. 2

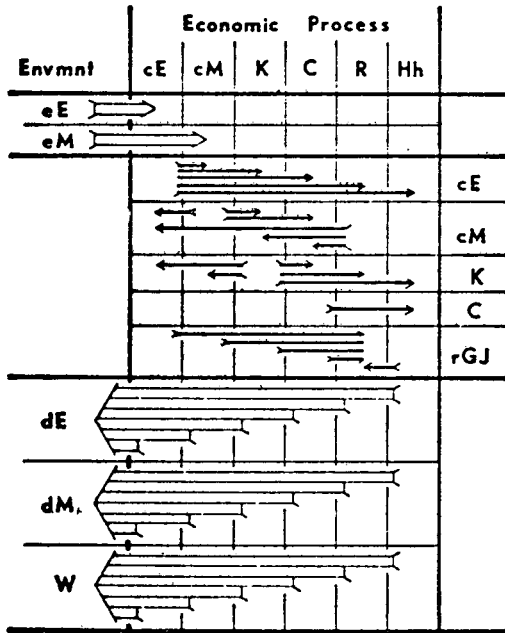


Fig. 3

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