

Hubbert's Prescription for Survival, A Steady State Economy

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The late Dr. M. King Hubbert, a geophysicist, is well known as a world authority on the estimation of energy resources and on the prediction of their patterns of discovery and depletion.

1. He was probably the best known geophysicist in the world to the general public because of his startling prediction, first made publicly in 1949, that the fossil fuel era would be of very short duration.
2. His prediction in 1956 that U.S. oil production would peak in about 1970 and decline thereafter was scoffed at then but his analysis has since proved to be remarkably accurate.

Less well known were Hubbert's studies since 1926 on the rate of industrial growth and of mineral and energy resources and their significance in the evolution of the world's present technological civilization. Clark in "Geophysics" in February 1983 states "In recent years, he (Hubbert) has assaulted a target -- which he labels the culture of money -- that is gigantic even by Hubbert standards. His thesis is that society is seriously handicapped because its two most important intellectual underpinnings, the science of matter-energy and the historic system of finance, are incompatible. A reasonable co-existence is possible when both are growing at approximately the same rate. That, Hubbert says, has been happening since the start of the industrial revolution but it is soon going to end because the amount the matter-energy system can grow is limited while money's growth is not.

"I was in New York in the 30's. I had a box seat at the depression," Hubbert says. "I can assure you it was a very educational experience. We shut the country down because of monetary reasons. We had manpower and abundant raw materials. Yet we shut the country down. We're doing the same kind of thing now but with a different material outlook. We are not in the position we were in 1929-30 with regard to the future. Then the physical system was ready to roll. This time it's not. We are in a crisis in the evolution of human society. It's unique to both human and geologic history. It has never happened before and it can't possibly happen again. You can only use oil once. You can only use metals once. Soon all the oil is going to be burned and all the metals mined and scattered." That is obviously a scenario of catastrophe, a possibility Hubbert concedes. But it is not one he forecast. The man known to many as a pessimist is, in this case, quite hopeful. In fact, he could be the ultimate utopian. We have, he says, the necessary technology. All we have to do is completely overhaul our culture and find an alternative to money.

"We are not starting from zero," he emphasizes. "We have an enormous amount of existing technical knowledge. It's just a matter of putting it all together. We still have great flexibility but our maneuverability will diminish with time."

A non-catastrophic solution is impossible, Hubbert feels, unless society is made stable. This means abandoning two axioms of our culture . . . the work ethic and the idea that growth is the normal state of affairs. Hubbert challenges the latter mathematically and concludes the exponential growth of the last two centuries is the opposite of the normal situation.

"It is an aberration. For most of human history the population doubled only once every 32,000 years. Now it's down to 35 years. That is dangerous. No biologic population can double more than a few times without getting seriously out of bounds. I think the world is seriously overpopulated right now. There can be no possible solutions to the world's problems that do not involve stabilization of the world's population."

Hubbert's ideas about work are even more heretical. Work is becoming, he says, increasingly unimportant. He thinks it is conceivable that the future work week might be on the order of 10 hours. Indeed, because production will have to be limited by increasingly limited mineral resources, that might

be inevitable. And that, Hubbert stresses, could be the foundation of an earthly paradise.

"Most employment now is merely pushing paper around," he says. "The actual work needed to keep a stable society running is a very small fraction of available manpower."

The key to making this cultural alteration is to come up with a limitless supply of cheap energy. Hubbert feels the answer is obvious--solar power--and he does not feel more technological breakthroughs are needed before it can be made universally available. His faith is not that of a knee-jerk trendy but that of a doubter who did much studying before his conversion.

"Fifteen years ago I thought solar power was impractical because I thought nuclear power was the answer. But I spent some time on an advisory committee on waste disposal to the Atomic Energy Commission. After that, I began to be very, very skeptical because of the hazards. That's when I began to study solar power. I'm convinced we have the technology to handle it right now. We could make the transition in a matter of decades if we begin now."

On June 4th, 1974 Hubbert testified before Representative Morris K. Udall's Subcommittee on the Environment.³ In his 21 page written statement he presented his familiar lecture on various growth curves, their equations, curves of world and U.S. production of fossil fuels as well as projections for the future. He next discussed the cultural aspects of the growth problem. He states, "during the last two centuries of unbroken industrial growth we have evolved what amounts to an exponential-growth culture. Our institutions, our legal system, our financial system, and our most cherished folkways and beliefs are all based upon the premise of continuing growth. Since physical and biological constraints make it impossible to continue such rates of growth indefinitely, it is inevitable that with the slowing down in the rates of physical growth cultural adjustments must be made.

One example of such cultural difficulty is afforded by the fundamental difference between the properties of money and those of matter and energy upon which the operation of the physical world depends. Money, being a system of accounting, is, in effect, paper and so is not constrained by the laws within which material and energy systems must operate. In fact money grows exponentially by the rule of compound interest." He next derives the equations for the growth of the stock of money, the rate of industrial growth and the generalized price level. The expression for the generalized price level states that this level "should increase exponentially at a rate equal to the difference between the rate of growth of money and that of industrial production. In particular, if the industrial growth rate a and the average interest rate i have the same values, then the ratio of money to what money will buy will remain constant and a stable price level should prevail. Suppose, however, that for physical reasons the industrial growth rate a declines but the interest rate i holds steady. We should then have a situation where i is greater than a with the corresponding price inflation at the rate $(i-a)$. Finally consider a physical growth rate $a=0$, with the interest rate i greater than zero. In this case, the rate of price inflation should be the same as the average interest rate. Conversely, if prices are to remain stable at reduced rates of industrial growth this would require that the average interest rate should be reduced by the same amount. Finally, the maintenance of a constant price level in a non-growing industrial system implies either an interest rate of zero or continuous inflation.

As a check on the validity of these deductions, consider the curves of U.S. energy and pig-iron production (which he shows in Figures 17 and 18.) Because energy is a common factor in all industrial operation and pig-iron production one of the basic components of heavy industry, the growth in the production of energy and pig iron is a very good indicator of the total industrial production.

Figure 17 is a graph plotted on a semilogarithmic scale of the production of energy from coal, oil, gas, and water power -- from 1850 to 1969. From 1850 to 1907 the production of energy increased exponentially at a rate of 6.91 percent per year, with a doubling period of 10.0 years. Then during the three-year period from 1907 to 1910, the growth rate dropped abruptly to a mean rate of 1.77 percent per year and the doubling period increased to 39 years.

Figure 18 is a corresponding plot of U.S. pig-iron production. The pig-iron curve resembles that of energy so closely that the two curves can hardly be told from one another. Pig-iron production also

grew exponentially at a rate close to 7 percent per year until about 1910, when it too broke abruptly to a lower rate of less than 2 percent per year. This abrupt break at about 1910 represents a major event in the industrial history of the United States, yet we have barely been aware that it happened.

In parallel with this industrial growth during most of the 19th century and continuing until 1929, the mean monetary interest rate was also about 7 percent per year. Therefore until 1910 the price level, except for temporary disturbances, should have remained comparatively stable. Following 1910, when the physical growth rate dropped to about 2 percent per year, whereas the interest rate remained at about 7 percent, a price inflation at a rate of about 5 percent per year should have begun. Despite fluctuations, the interest rate has remained consistently higher than the physical growth rate from 1910 to the present, which implies that we should have had an almost continuous price inflation for the last 64 years.

A graphical illustration of the relations between the monetary growth, physical growth and price inflation is shown in Figure 19. The upper straight line represents the exponential growth of money at the interest rate i ; the lower curve the physical growth at the lower rate a . The ratio of M (money growth) to Q (industrial growth) at any given time is proportional to the distance between those curves. If the curves are parallel, the spacing is constant and a stable price level will prevail. If the curves are divergent to the right, the price level will increase at the rate $(i-a)$ "

These curves depict the approximate relation between the monetary growth rate and the physical growth rate that has prevailed in the United States since 1910.

Finally, as confirmatory evidence, there is shown in Figure 30 a graph of the consumer price index as computed for each year from 1800 to 1971 by the U.S. Bureau of Labor Statistics. The three principal distortions coincide with the War of 1812, the Civil War, and World War I. Disregarding these, and drawing a smooth curve under the bases of each gives a very informative result. For the period from 1800 to 1910 the consumer price level remained remarkably stable. Beginning about 1910, at the time of the abrupt drop in the rate of industrial growth, prices began to inflate and they have continued to do so to the present time.

The foregoing example has been discussed in detail because it serves as a case history of the type of cultural difficulties which may be anticipated during the transition period from a phase of exponential growth to a stable state. Since the tenets of our exponential-growth culture (such as a non zero interest rate) are incompatible with a state of non growth, it is understandable that extraordinary efforts will be made to avoid a cessation of growth. Inexorably, however, physical and biological constraints must eventually prevail and appropriate cultural adjustments will have to be made."

During the question period after Dr. Hubbert's testimony Mr. Udall asked,--"this inflation that we are all so concerned about now may not necessarily be mismanagement of the economy or some temporary problems necessarily, but may be built into this whole problem of exponential growth in terms of the population and use of resources, and so on. Is that what you are saying?" Dr. Hubbert's reply was, "It has been going on, the record is unequivocal, since 1910, disregarding the disturbance of World War I."

Does Dr. Hubbert have a recommendation for the overhaul of our culture and an alternative to money? When I spoke to him by telephone in about 1970 he confirmed that he did. His suggestion was that income in units of energy could be used. In a 30 page research paper which he published while at Columbia in August 1936 titled "MAN-HOURS--A DECLINING QUANTITY"[4] he wrote, "the American public has watched both government and business indulge in the curtailment of food production and its wholesale destruction at a time of the greatest human need in American history. They have seen their factories closed at a time when a large fraction of the population has been in want of the products of industry and when millions have been willing and anxious to work.-- What is there so difficult about the problem? What is it that has to be done in order to solve it? Simply and solely that our Continental totality shall be operated at a maximum of efficiency with a maximum conservation of resources for the maximum production and distribution of physical wealth--with a resultant standard of living greater than has ever been obtained on the North American Continent. To do this requires a distributive mechanism

that will deliver the products of industry to the consuming public at whatever rate is required.

Getting something for nothing

In the distribution to the public of the products of industry, the failure of the present system is the direct result of the faulty premise upon which it is based. This is: that somehow a man is able by his personal services to render to society the equivalent of what he receives, from which it follows that the distribution to each shall be in accordance with the services rendered and that those who do not work must not eat. This is what our propagandists call 'the impossibility of getting something for nothing.' Aside from the fact that only by means of the sophistries of lawyers and economists can it be explained how, on this basis, those who do nothing at all frequently receive the largest shares of the national income, the simple fact is that it is impossible for any man to contribute to the social system the physical equivalent of what it costs the system to maintain him from birth till death--and the higher the physical standard of living the greater is this discrepancy. This is because man is an engine operating under the limitations of the same physical laws as any other engine. The energy that it takes to operate him is several times as much as any amount of work he can possibly perform. If, in addition to his food, he receives also the products of modern industry, this is due to the fact that material and energy resources happen to be available and, as compared with any contribution he can make, constitute a free gift from heaven. Stated more specifically, it costs the social system on the North American Continent the energy equivalent to nearly 10 tons of coal per year to maintain one man at the average present standard of living, and no contribution he can possibly make in terms of the energy conversion of his individual effort will ever repay the social system the cost of his social maintenance. Is it not to be wondered at, therefore, that a distributive mechanism based upon so rank a fallacy should fail to distribute; the marvel is that it has worked as well as it has. Since any human being, regardless of his personal contribution, is a social dependent with respect to the energy resources upon which society operates, and since every operation within a given society is effected at the cost of a degradation of an available supply of energy, this energy degradation, measured in appropriate physical units such as kilowatt-hours, constitutes the common physical cost of all social operations. Since also the energy-cost of maintaining a human being exceeds by a large amount his ability to repay, we can abandon the fiction that what one is to receive is in payment for what one has done, and recognize that what we are really doing is utilizing the bounty that nature has provided us. Under these circumstances we recognize that we all are getting something for nothing, and the simplest way of effecting distribution is on a basis of equality, especially so when it is considered that production can be set equal to the limit of our capacity to consume, commensurate with adequate conservation of our physical resources.

Income in Units of Energy

On this basis our distribution then becomes foolproof and incredibly simple. We keep our records of the physical costs of production in terms of the amount of extraneous energy degraded. We set industrial production arbitrarily at a rate equal to the saturation of the physical capacity of our public to consume. We distribute purchasing power in the form of energy certificates to the public, the amount issued to each being equivalent to his pro rata share of the energy-cost of the consumer goods and services to be produced during the balanced-load period for which the certificates are issued. These certificates bear the identification of the person to whom issued and are non negotiable. They resemble a bank check in that they bear no face denomination, this being entered at the time of spending. They are surrendered upon the purchase of goods or services at any center of distribution and are permanently canceled, becoming entries in a uniform accounting system. Being nonnegotiable they cannot be lost, stolen, gambled, or given away because they are invalid in the hands of any person other than the one to whom issued. If lost, like a bank checkbook, new ones may be had for the asking. Neither can they be saved because they become void at the termination of the two-year period for which they are issued. They can only be spent. Contrary to the Price System rules, the purchasing power of an individual is no longer based upon the fallacious premise that a man is being paid in proportion to the so-called 'value' of his work (since it is a physical fact that what he receives is greatly in excess of his individual effort) but upon the equal pro rata division of the net energy degraded in the production of consumer goods and services. In this manner the income of an individual is in nowise dependent upon the nature of his work, and we are then left free to reduce the working hours of our population to as low

a level as technological advancement will allow, without in any manner jeopardizing the national or individual income, and without the slightest unemployment problem or poverty. "

Hubbert goes on to state that following a transition the work required of each individual, need be no longer than about 4 hours per day, 164 days per year, from the ages of 25 to 45. Income will continue until death. "Insecurity of old age is abolished and both saving and insurance become unnecessary and impossible."

My personal conclusions and recommendations are:

1. We will never again be able to get sufficient growth of the economy to eliminate or even markedly reduced unemployment. NAFTA, GATT, and Clinton's hope of growing the economy to solve unemployment is doomed to failure.
2. The promise of competing in the global economy is a hoax perpetrated upon the working and unemployed people of this country because over time a nation needs to buy and sell overseas in roughly equivalent amounts.
3. All attempts to reduce the deficit, balance the budget or pay off the national debt are futile. The deficit and the national debt represent the subsidy the government has paid in its attempt to keep growth and unemployment at the level of social tolerance.
4. The steady state economy into which we are being inexorably forced implies an interest rate of zero.
5. An interest rate of zero (as Hubbert explains) means the end of the money system. We are being forced to completely rethink our cultural ideas about how to organize our economy and distribute purchasing power.
6. Increasingly desperate means will be used by those who think we can continue to have business as usual.
7. The proposals of Negative Population Growth should be implemented immediately.

References

1. 1 Albert A. Bartlett, "Forgotten fundamentals of the energy crisis," Am. J. Phys., Vol. 46. No. 9, September 1978
2. 2. Clark, Robert Dean, Assistant Editor, Geophysics: The Leading Edge of Exploration, "King Hubbert", February 1983. pp.16-24
3. 3 Hubbert, Dr. M. King, research geophysicist, Washington, D.C. June 4, 1974 Testimony before Subcommittee on the Environment of the Committee on Interior and Insular Affairs, House of Representatives, Ninety-Third Congress , Serial no. 93-55 U.S. Government Printing Office, Washington: 1974
4. 4 Hubbert, M. King, "Man Hours-A Declining Quantity," as Published in Technocracy Series A. No. 8 August 1936
5. Additional recommended reading material:
6. Daly, Herman E. "Toward a Steady-State Economy", 1973 W. H. Freeman & Co.
7. Daly, Herman E. and Cobb, John B. Jr. "For the Common Good, Redirecting the Economy Toward Community, the Environment and a Sustainable Future", 1989 Beacon Press
8. Daly, Herman E., & Townsend, Kenneth N. editors, "Valuing the Earth, Economics, Ecology, Ethics"

9. Theobald, Robert, "The Challenge of Abundance", 1962 Mentor Books
10. Theobald, Robert, "The Guaranteed Income, Next Step in Socioeconomic Evolution?", 1967 Anchor Books
11. Theobald, Robert, editor, "Committed Spending, A Route to Economic Security" 1969 Anchor Books
12. Theobald, Robert, "The Economics of Abundance, A Non-Inflationary Future", 1970 Pitman Publishing Corp.
13. Theobald, Robert, "The Rapids of Change, Social Entrepreneurship in Turbulent Times" 1986 Knowledge Systems, Inc.
14. Theobald, Robert, "Turning the Century" Personal and Organizational Strategies for Your Changed World" 1992 Knowledge Systems, Inc.
15. Watt, Kenneth E. F., "The Titanic Effect , Planning for the Unthinkable" 1974 Sinauer Associates, Inc.

M. King Hubbert. 1981

"Two Intellectual Systems: Matter-energy and the Monetary Culture":

"The World's present industrial civilization is handicapped by the co-existence of two universal, overlapping, and incompatible intellectual systems: the accumulated knowledge of the last four centuries of the properties and interrelationships of matter and energy; and the associated monetary culture which has evolved from folkways of prehistoric origin.

The first of these two systems has been responsible for the spectacular rise, principally during the last two centuries, of the present industrial system and is essential for its continuance. The second (monetary culture), an inheritance from the pre-scientific past, operates by rules of its own having little in common with those of the matter-energy system. Nevertheless, the monetary system, by means of a loose coupling, exercises a general control over the matter-energy system upon which it is super-imposed.

Despite their inherent incompatibilities, these two systems during the last two centuries have had one fundamental characteristic in common, namely exponential growth, which has made a reasonable stable co-existence possible. But, for various reasons, it is impossible for the matter-energy system to sustain exponential growth for more than a few tens of doublings, and this phase is almost now over. The monetary system has no such constraints, and, according to one of its fundamental rules, it must continue to grow by compound interest. This disparity between a monetary system which continues to grow exponentially and a physical system which is unable to do so leads to an increase, with time, in the ratio of money to the output of the physical system. THIS MANIFESTS ITSELF AS PRICE INFLATION. It appears that the stage is now set for a critical examination of this problem, and that out of such enquiries, if a catastrophic solution can be avoided, there can hardly fail to emerge what the historian of science, Thomas S. Kuhn, has called a major scientific and intellectual revolution.

I was in New York in the 30's. I had a box seat at the depression. I can assure you it was a very educational experience. We shut down the country because of monetary reasons. We had manpower and abundant raw materials. Yet we shut the country down. We are doing the same kind of thing now but with a different material outlook. We are not in the position we were in 1929-30 with regard to the future. Then the physical system was ready to roll. This time it is not. We are in a crisis in the evolution of human society. It's unique to both human and geological history. It has never happened before and it can't possibly happen again. You can only use oil once. You can only use metals once.

Soon all the oil is going to be burned and all the metals mined and scattered. That is obviously a scenario of catastrophe but we have the technology. All we have to do is completely overhaul our culture and find an alternative to money. We are not starting from zero. We have an enormous amount of existing technical knowledge. It's just a matter of putting it all together. We still have great flexibility but our maneuverability will diminish with time. A NON-CATASTROPHIC SOLUTION IS IMPOSSIBLE UNLESS SOCIETY IS MADE STABLE. This means abandoning two axioms of our own culture the (current) work ethic and the idea that growth is the normal state of life. Our window of opportunity is slowly closing, at the same time, it probably requires a spiral of adversity. In other words things have to get a lot worse before they can get better. The most important thing is to get a clear picture of the situation we're in and the outlook for the future."

M. King Hubbert, 1974

"On The Nature Of Growth"

Submission to the House of Representatives

National Energy Conservation Policy Act Hearings

"Two terms applicable to an evolving system are of fundamental importance. These are steady state and transient state.

A system is said to be in a steady state when its various components either do not change with time, or else vary cyclically with the repetitive cycles not changing with time (i.e. the seasons). A system in a transient state is one whose various components are undergoing non-cyclical changes in magnitude, either increase or decrease.

Transition From Steady State To Transient State Due To Fossil Fuels:

By about 2 million years ago biological evolution had advanced to where the ancestors of the present human species had begun to walk upright and to use crude stone tools. At that stage this species must have existed as a member of an ecological complex and competed with other members of the complex for a share of the local solar energy essential for its existence. The energy utilizable was almost exclusively the food supply derived by the biological system from solar energy by the mechanism of photosynthesis. During the subsequent million or more years the human species progressively devised means of capturing an ever-larger supply of the available energy. In view of the slowness with which these developments must have occurred, the whole ecological system of which the human species was a member can only be regarded as comprising a slowly changing ecological steady state.

Although the pace quickened about 8,000 to 10,000 years ago, with the domestication of plants and animals, a rapidly changing transient state of evolution was not possible until the large supplies of energy stored in fossil fuels began to be utilized-when the mining of coal as a continuous enterprise was begun near Newcastle in Northeast England about 9 centuries ago. This was followed as recently as 1857 in Romania and in 1859 in the United States by the exploitation of the second major source of fossil-fuel energy, petroleum.

What is most particular about the history of coal production is the large contrast between the magnitudes of the rate of coal production following the year 1800 and that, which must have prevailed during the preceding 7 centuries. From earlier statistics it can be estimated that the cumulative coal production during the eight hundred years before 1860 amounted altogether to only

about 7 billion metric tons, whereas 133 billion metric tons, or 19 times as much coal, was mined during the 110-year period from 1860 to 1970.

Constraints On Growth:

In addition to supplies of energy, other constraints operate to modify growth. These constraints may be broadly classified as being ecological in nature. For more than a century it has been known in biology that if any biological species from microbes to elephants is given a favourable environment, its population will begin to increase at an exponential rate. However, it was also soon established that such a growth rate cannot long continue before retarding influences set in. In our earlier review of the rates of production of the fossil fuels it was observed that for close to a century in each case the production increased exponentially with doubling periods within the range of 8 to 16 years.

The present world population (1974) is about 4 billion, which is increasing at a rate of about 2 per cent per year, with a doubling period of about 35 years. What could have been the minimum average doubling period during the last million years? This minimum would occur if we make a wholly un-realistic assumption, namely that the population a million years ago was the biological minimum of 2. How many doublings of this original couple would be required to reach the World's present 4 billion? Slightly less than 31. Hence, the maximum number of times the population could have doubled during the last million years would have been 31 with the average period of doubling being 32,000 years. Consequently when we compute a maximum average growth rate between the finite levels of population at a time interval of a million years, we arrive at the same conclusion, **NAMELY THAT THE NORMAL STATE, THE STATE THAT PERSISTS MOST OF THE TIME, IS ONE OF AN APPROXIMATE STEADY STATE.** The abnormal state of an ecological system is a rapidly changing transient or disturbed state.

To obtain an idea of how long a disturbed or transient state can persist a fundamental question that may be asked is: about how many doublings of any biological or industrial component can the earth itself tolerate? A clue to this may be obtained if we consider the problem of the grains of wheat and the chessboard. According to an ancient story from India, a king wished to reward one of his subjects for some meritorious deed. The man replied that his needs were few and he would be satisfied to receive a bit of corn. If one grain were placed on the first square of a chess board, two on the second, four on the third, and the number of grains were doubled for each successive square, he would be content to receive that amount of grain. The king ordered the board to be brought in and the grain counted out. To his consternation he found that there was not enough wheat in the kingdom. i.e. 2 to the power of 64, this amount of wheat, it turned out would be 2000 times the World's present annual wheat crop. This may appear to be a trivial problem; its implications are actually profound. The Earth itself cannot tolerate the doubling of one grain of wheat 64 times. The same principles and the same kind of constraints apply when we are dealing with successive doublings of any other biological or industrial component. Even if there are no shortages of energy or of materials the Earth will not tolerate more than a few tens of doublings

Cultural Aspects Of The Growth Problem:

WITHOUT FURTHER ELABORATION, IT IS DEMONSTRABLE THAT THE EXPONENTIAL PHASE OF THE INDUSTRIAL GROWTH WHICH HAS DOMINATED HUMAN ACTIVITY

DURING THE LAST COUPLE OF CENTURIES IS DRAWING TO A CLOSE. It is physically and biologically impossible for any material and energy component to follow exponential growth for more than a few tens of doublings, and most of those possible doublings have already occurred. Yet, during the last two centuries of unbroken industrial growth we have evolved WHAT AMOUNTS TO AN EXPONENTIAL GROWTH CULTURE. Our institutions, our legal system, our financial system, and our most cherished folkways and beliefs are all based upon the premise of continuous growth. Since physical and biological constraints make it impossible to continue such rates of growth indefinitely, it is inevitable that with the slowing down in the rates of physical growth CULTURAL ADJUSTMENTS MUST BE MADE."