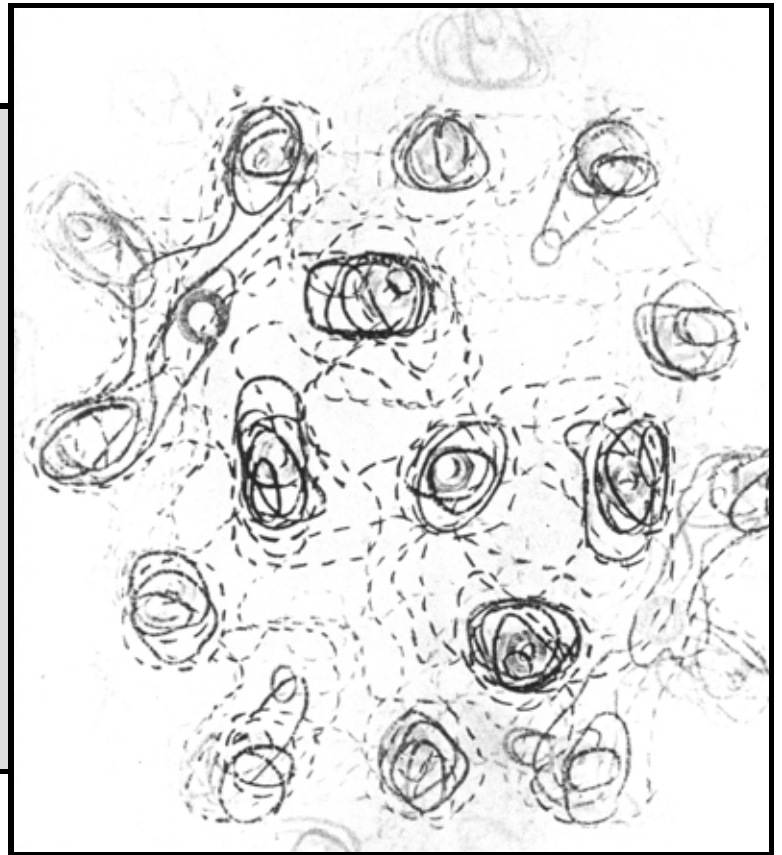


SCIENCE, ECONOMICS AND THE SPONTANEOUS ORDER

BRUCE N. AMES



INTRODUCTION

The power of modern science is the result of its being a spontaneously ordered system, not a centrally planned one. Individual scientists are fairly free to follow their own enthusiasms and interests. A million scientists, from a multitude of countries publish scientific papers, go to meetings, exchange their ideas, and communicate new techniques. New fields develop and old ones die, and all the while there is an ever-increasing understanding of the universe.

How can this community of scholarship flourish when science has its fair share of people who are self-serving, incompetent, dishonest, power-hungry, unscrupulous, and lacking in common sense? Scientists are

well represented in both the human vices and virtues. The scientific endeavor, as it has evolved over the last few hundred years, has developed its own screens and incentives to deal with human imperfection and to facilitate discovery. One essential screen is that our peers in our immediate specialty referee our scientific papers before they are published in journals. This weeds out papers that lack controls, logic, novelty, or have other defects. A series of conventions has evolved, including the practice of justifying each statement by a citation of the scientific literature, and that of describing new experiments with sufficient detail for other professional scientists to repeat them. I think this essential aspect of science - that it is a spontaneous order with screens to weed out destructive habits - has led to its marvelous complexity and strength. Doing good science is not equivalent to putting a man on the moon. It's impossible to predict beforehand which individuals have the capacity to make the next great breakthroughs. Therefore, it is better to have a decentralized, spontaneous system with freedom for individuals.

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I. TWO APPROACHES TO SCIENCE

I would like to give you an example from my own experience of the contrast between spontaneous science and centrally planned science. After getting my Ph.D. at Cal Tech, I went to the National Institutes of Health (NIH) in Bethesda, Maryland and spent a good part of my scientific career there. I was in the National Institute of Arthritis and Metabolic Diseases, which was a wonderful place to be. I think the Arthritis Institute was outstanding because its administra-

tors felt that their role was to hire the best young people in the country and give them the freedom to do what they wanted to do. On the other hand, the National Cancer Institute (NCI), another part of NIH, was a much more structured and planned operation at that time. Many of us felt the directors had an excessive preoccupation with planning, which necessarily meant that they had some strong ideas about what cancer research should be like. I still remember reading in some report by an NCI official that bacteria had nothing to teach us about cancer. This attitude on the part of the NCI was expressed at the very time when the foundations of modern molecular biology were being established with bacteria and bacterial viruses, much of it at the NIH. My reaction to the NCI's approach was that if an understanding of cancer was to come out of the NIH, it would come out of the Arthritis and Metabolic Diseases Institute.

A few years later, I had some secret satisfaction when our work on bacteria had a major impact on cancer research. My own work focused on how genes are turned on and off in bacteria to change regulatory mechanisms. At about this time, I became concerned with all of the new synthetic chemicals that were being added to food; I thought it would be useful to develop a test system for detecting mutagens in order to ensure that no unsuspected mutagens could suddenly appear in the American diet. Thus, as a hobby, and as a side project to my regular research, I began to develop a bacterial test system for detecting mutagens. In the course of doing this, I began to do basic research in mutagenesis, as well as work to develop a comprehensive screening system for detecting mutagens. I also became intrigued with the old idea (which had fallen somewhat into disrepute) that carcinogens were causing cancer because they were mutagens. Our work went quite well, and when I left NIH to go to the University of California at Berkeley in 1967, I applied for a grant from the National Cancer Institute so that I could continue this work. I, of course, discussed why I thought mutagenesis was relevant to cancer. The grant was turned down as being irrelevant to cancer research, but fortunately it was funded by the Atomic Energy Commission, which happened to be supporting work in mutagenesis at that time because of its interest in radiation. Now our test system is in use in three thousand labs around the world as a primary screen for identifying potential carcinogens. Later, I also served a term on the Board of Directors of the NIC. Today NCI is a very different organization.

I have seen science in operation in many countries. One strength of American science is the high level of independence given to young people, who have the freedom to join the system, cooperate and compete with their fellow scientists, and be judged by their peers. On the other hand, in societies that have strong central planning of science, the positions of power are fewer and more important, and the incentives to act

politically to advance one's career are very strong. As a consequence, people are corrupted by politicking and distracted from producing good science. Another enormous advantage in Western science, particularly in comparison to the socialist countries, is the flourishing of small companies that can rapidly provide the chemicals and the tools needed, for the constantly changing areas of interest.

Despite the success of spontaneous orders, there seems to be a fair amount of hostility to them these days. There is, instead, a fascination with central planning to achieve whatever utopia is fashionable.

II. PHILOSOPHY AND THE SPONTANEOUS ORDER

In the United States, our Founding Fathers thought that checks and balances on the power of the state combined with the maximum amount of human freedom compatible with the minimization of coercion, acted as appropriate screens for an evolving spontaneous order. They succeeded pretty well. When we look at the many human lifestyles and mini-utopias that have appeared in the United States, it is a thing of wonder: the Amish and the Southern Baptists, the Mormons and the Quakers - rural life and urban life in a variety of flavors. In modern California we seem to be getting hundreds of such flowers blooming: Zen Buddhists, Moonies, Hare Krishnas, and other marvelously strange cults and religions; Marin County, Orange County, and even jogging as a way of life. As Frank Lloyd Wright said, "Someone tipped the U.S. up on end and everything loose fell into California."

Reading several books on spontaneous orders has excited me this past year. One book, *Anarchy, State and Utopia*, was the winner of the National Book Award several years ago. It was written by Robert Nozick, professor of philosophy at Harvard.

Nozick examines both the idea of utopia and the relation of the state to utopia. He discusses the remarkable diversity of human beings and their various desires, and he points out that the utopias desired are mostly incompatible with each other. In addition, there is a big gap between the anticipated and the actual evolution of any complex system.

Nozick's own idea of utopia is that of a framework for competing ideas of utopia within which various schemes compete with and influence each other. A necessary qualification for each of these schemes is the elimination of coercion by either the particular utopias or the state.

The following quotes from Nozick give an idea of his style and philosophy:

"No state more extensive than the minimal state can be justified. But doesn't the idea, or ideal, of the minimal state lack luster? Can it thrill the heart or inspire people to struggle and sacrifice?"

Would anyone man barricades under its banner? It seems pale and feeble in comparison with, to pick the polar extreme, the hopes and dreams of utopian theorists. Whatever its virtues, it appears clear that the minimal state is no utopia.”¹

He then goes on to examine the idea of an evolving framework of utopias, based on the premise of no coercion. He finishes his book thus:

“Recall now the question with which this chapter began. Is not the minimal state, the framework for utopia, an inspiring vision? The minimal state treats us as inviolate individuals, who may not be used in certain ways by others as means or tools or instruments or resources; it treats us as persons having individual rights with the dignity this constitutes. Treating us with respect by respecting our rights, it allows us, individually or with whom we choose, to choose our life and to realize our ends and our conception of ourselves, insofar as we can, aided by the voluntary cooperation of other individuals possessing the same dignity. How *dare* any state or group of individuals do more. Or less.”²

III. THE SPONTANEOUS ORDER OF NATURE

Nozick’s insights on evolutionary processes are well worth repeating:

“We should not be *too* haughty about the results of filter processes, being one ourselves ... evolution is a process for creating living beings appropriately chosen by a modest deity, who does not know precisely what the being he wishes to create is like.”³

Evolution has given us a world of marvelous complexity. The current fashion seems to be to worship this world as something more benign than it really is. Environmentalists are agitated because I have pointed out that nature is not benign. They are terribly worried about man-made pesticides, but it is turning out that almost all of the pesticides we are ingesting are nature’s pesticides. About 5% of every plant is toxic chemicals, and these chemicals comprise an amazing zoo of nasty things. Their function, of course, is the defense against insects, fungi, and other predators, including man. Evolution constantly produces new and nastier plant pesticides; it also produces hardier predators able to cope with particular toxic compounds. *Chemical warfare flourishes in plants.* There are thousands of these compounds in the human diet (solanine and chaconine in potatoes, tomatine in tomatoes, canavanine in alfalfa sprouts, etc.). The amounts we ingest are enormous compared to man-made pesticides residues (I would estimate at least ten thousand times more), and very little toxicological research has been done in this area. Now that scientists are studying the toxicology of nature’s pesticides, they are finding an unpleasant variety of mutagens, carcinogens, and tera-

togens. We are beginning to realize that the risk from man-made pesticides (or pollutants, for that matter) that humans ingest in their diets is utterly trivial, relative to the background of hazardous compounds provided by nature. The main alternative to using man-made pesticides is to grow crops that have been bred to contain higher levels of nature’s pesticides. I have little doubt that both health and economics will be on the side of human ingenuity, inventing better and better pesticides that are less dangerous to humans than their natural counterparts.

We must also remember that humans would not be here, were it not that a good part of the flora and fauna of the world (including the dinosaurs) was wiped out by a shower of comets. Evolution is a never-ending process of some species being wiped out and others taking their place. This realization makes all the more puzzling the present intellectual fashion, which is to think that the world would be a marvelous place if only man weren’t there to mess it all up.

IV. MARKETS AS SPONTANEOUS ORDERS

Man has created a civilization of wondrous variety and complexity. In the words of the eighteenth century Scottish moral philosopher, Adam Ferguson, civilization is “the result of human action, but not the execution of any human design.”⁴ The most renowned contemporary expositor of this spontaneous order is Friedrich Hayek, an Austrian economist and social theorist who won the Nobel Prize a few years ago. Hayek is a thinker of enormous depth and scope. I have been exhilarated by reading his books these last few years.

Hayek discusses the market as a system of spontaneous order, which has evolved from a framework of individual freedom, non-coercion, voluntary exchange between people, and private property. He points out that the spontaneous order of the market has many advantages: “Knowledge that is used in it is that of all of its members. Ends that it serves are the separate ends of those individuals, in all their variety and contrariness.”⁵ In Hayek’s view, the market order is superior to a centrally planned economy because it is a framework for human action that does not require agreement on what aims are to be pursued. It thus allows men with different purposes and values to live together peacefully and to their mutual benefit. As pointed out by Adam Smith, “It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interests.”⁶

Hayek characterizes the price system in a complex worldwide market as a very efficient mechanism for condensing a tremendous amount of information in order to indicate the true costs of production and consumption. The price system is a spontaneous order that allows people to make rational economic deci-

sions because it constantly changes in response to the changing world.

“We must look at the price system as ... a mechanism for communicating information if we want to understand its real function ... Through it, not only a division of labor but also a co-ordinate utilization of resources based on an equally divided knowledge has become possible.”⁷

In Hayek’s view, prices inform producers how much skill and labor it is worth putting in a product. This is the inverse of Marx’s labor theory of value, which held that the labor invested in a product determined its value.

I thought of this when my friend Art Rosenfeld, a physics professor at Berkeley who is one of the leaders in the world in the area of energy conservation, was invited to China and the Soviet Union to advise them on how to save energy. He found that both countries were enormously more wasteful of energy than the Western countries or Japan. Both communist countries were keeping energy prices very low: therefore, people had little incentive to conserve energy.

A Polish scientist recently told me a relevant Eastern European joke. After the whole world turns communist, the commissars should leave one capitalist country intact, in order to know what prices to charge for things.

Hayek also discusses competition as a knowledge-generating system. We know, for example, that restaurants are always opening and failing. The proprietors of an unsuccessful restaurant presumably gain some knowledge about the public’s likes and dislikes, and perhaps the work habits that it takes to run a restaurant. They can either go into another business if they can’t adjust, or they can emulate the more successful restaurants.

Hayek’s view on this is that:

“... competition ... not only shows how things can be done more effectively, but also confronts those who depend for their incomes on the market with the alternative of imitating the more successful or losing some or all of their income. Competition produces in this way a kind of impersonal compulsion which makes it necessary for numerous individuals to adjust their way of life in a manner that no deliberate instructions or commands could bring about.”⁸

In a fiercely competitive system such as the modern world economy, monopolies are hard to preserve except through government ownership or regulation. The Fortune 500 list changes every year. Apple Computer was started in a garage by two college dropouts, and it created a new market under the shadow of the mighty IBM. Even inefficient government monopolies can sometimes be attacked, as can be seen by the

spectacular rise of Federal Express and U.P.S. in competition with the United States Postal Service. New ideas are always coming into the system when there is freedom and competition, both in the market economy and the scientific endeavor, thus maximizing wealth and knowledge.

As Hayek views it, central to the very nature of a spontaneous order is the concept of a free society as something which arises out of the actions of men and women, but which is not consciously planned. Any attempt to construct a society, says Hayek, by social engineering or in accordance with some preconceived idea inevitably leads to a tyranny which cannot find room for the multitude of needs and wishes that motivates its members.

“If man is not to do more harm than good in his efforts to improve the social order, he will have to learn that in this, as in all other fields where essential complexity of an organized kind prevails, he cannot acquire the full knowledge which would make mastery of the events possible. He will therefore have to use what knowledge he can achieve, not to shape the results as the craftsman shapes his handiwork, but rather to cultivate a growth by providing the appropriate environment, in the manner in which the gardener does this for his plants.”⁹

Those of us who teach and do research in the flourishing garden of science see the cultivation of this garden as a joyful and fulfilling human endeavor. As Thomas Jefferson said:

“[Science] is the work to which the young men ... should lay their hands. We have spent the prime of our lives in procuring them the precious blessing of liberty. Let them spend theirs in showing that it is the great parent of science and virtue; and that a nation will be great in both always in proportion as it is free.”

NOTES

1. Robert Nozick, *Anarchy, State and Utopia*, New York, Basic Books, 1974, p. 297.
2. *Ibid.*, pp. 333-334.
3. *Ibid.*, p. 314.
4. Adam Ferguson, *An Essay on the History of Civil Society*, Edinburgh, Edinburgh University Press, 1767, p. 122.
5. Friedrich A. Hayek, *New Studies in Philosophy, Politics, Economics and the History of Ideas*, Chicago, University of Chicago Press, 1978, p. 183.
6. Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*, ed. R. H. Campbell and A. S. Skinner, Oxford, Clarendon Press, 1976, pp. 26-27.
7. Friedrich A. Hayek, *Individualism and Economic Order*, Chicago, University of Chicago Press, 1956, p. 86.
8. Hayek, *New Studies*, op cit., p. 189.
9. *Ibid.*, p. 34.