The Economic Significance of Speculations in Science

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Abstract: The growth and development of economies can be described as a logistic evolution process, for which we have a mathematical formulation. This shows that without innovation highly developed economies go into recession or even depression. To prevent or repair this we need a stream of inventions, leading to innovations. Those inventions are based on new developments in science. For that we need scientists who are engaged in speculative theories. However, in times of growth there is no need for such people, they even become outsiders or mavericks. Until the phase of growth reaches its end and consequently the economies go into recession. It is very difficult for most people to see what is happening then as they are used to the continuous growth. When the insight comes it is difficult to find new inventive scientists within the good old organization of science. Some mavericks are perhaps present in their own way and hopefully they find their way to new science, new paradigms and inventions. Only then the economies can get out of the depressed state.

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1. Normal science

Each science has some basic ideas, just as each industry has some basic inventions. They are of crucial importance and in their time they were even considered as revolutionary or of paradigmatic value. They were the fruit of successful speculation in the past. Often we have almost forgotten how the world looked like before these basic ideas grew roots.

Scientists have been trained within this paradigm. In a way it has become routine knowledge, or 'normal science' as described by Kuhn[1]. Mainstream science has little room for speculation anymore. Science is developing hand in hand with industries and government, where we find the same situation: a bureaucracy, every day's business routines. Government is prepared to pay part of the research bill of normal science. Normal scientists are happy to advise industry and government. Speculation is not considered, and neither are the ideas of 'outsiders' or 'mavericks'. The ideas or proposals of the latter have little chance of being accepted within the technostructure. So we can hardly expect speculation to have an important role to play.

2. Economic vitality

Economic development is triggered by inventions and innovations. The growth of production (y) from such innovations follows a sigmoid curve with $y_{t+1} = ky_t - ky_t^2$ as the basic equation (called the logistic equation or curve). New innovations can give rise to even more efficient growers (with higher k values), and these may be more effective in the market place (see Figure 1 based on the Prigogine[2] theory of logistic evolution). Science and technology can produce such higher k values. That is economically very significant.

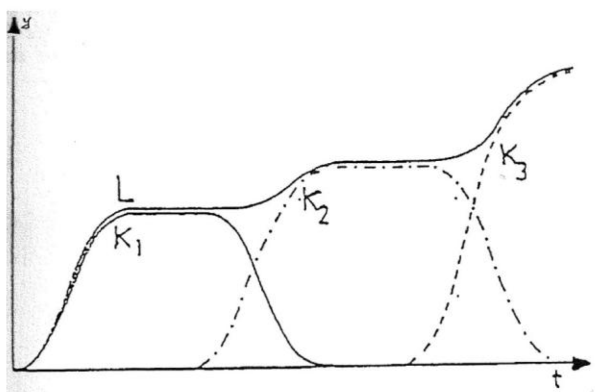

Figure 1. Evolution of total population y as function of time

As in nature, the higher k value has disadvantages too: the growing population becomes more vulnerable and less stable. This weakness is dangerous if there is a high degree of rivalry and competition, because it decreases the vitality of that industry. Moreover, a stream of improvements in the production process may compensate for it. Vitality is a complex concept[3], but we

[1] Kuhn, T.S. (1962). The Structure of Scientific Revolutions, Chicago; Ruse, M. (1993). The Darwinian Paradigm, London; Casti, J.L., Paradigms Lost, (Morrow), New York.

[2] Prigogine, I & I. Stengers, 1984. Order out of chaos, New York.

[3] Noort, P.C. van den (1994). Growth as a Prerequisite for

can summarize its various aspects with an equation:

$$vitality\ index = N = \frac{Wh\,S + (1 - Wh)G}{R}$$

in which:

S = stability
G =growth
W = degree of competition
R = resistance of the environment or vulnerability of the species
h = type of equilibrium (stream of innovations)

If there is indeed a stream of innovations then h = 0 and, therefore, N = G/R. We found that G = log k, R = k and s = (k-1) (2.6-k). So the vitality index will be as in Figure 2: the normal evolutionary situation of growth and survival of the fittest. Normal science produces a stream of new ideas and inventions which enables industries to innovate. This gives industry vitality and this is what keeps science and technostructure together to their mutual benefit.

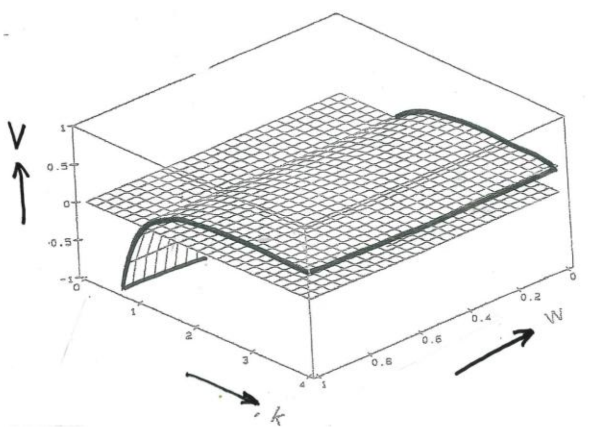

Figure 2 The Stable Ecological Hierarchy in case of increasing mutations
V=vitality, k=coefficient of growth, w=degree of competition, w=0=monopoly, w=1=pure competition (Noort, 1995)

Sometimes it is also beneficial to have a monopoly, because then there is less to fear from competitors. Innovation and invention can then also be applied because this suits business. Science too can have an exclusive policy. Some scientists will have no luck in getting their ideas accepted. Neither normal science nor the technostructure likes mavericks or outsiders. So there must be a number of frustrated scientists and managers: generally there is no joy in being rejected.

3. Fallibility

The history of science shows that however majestic the leaders of science or technostructure may appear, they are still fallible: they may reject good ideas and accept bad ones. The politics of science and of R&D may delay or even prevent innovation. It is conceivable that the stream of innovation will dry up. At first sight this does not appear to be very important. Such highly developed, specialized firms (that often rule the markets too) will have only a pause, a tea break so to say[4]. In reality we see the stream of innovations decreasing, h = 0 changing into h = 1 and the vitality index showing quite a different picture, see Figure 3. The top caves in and becomes extinct, leading to an economic recession or even depression.

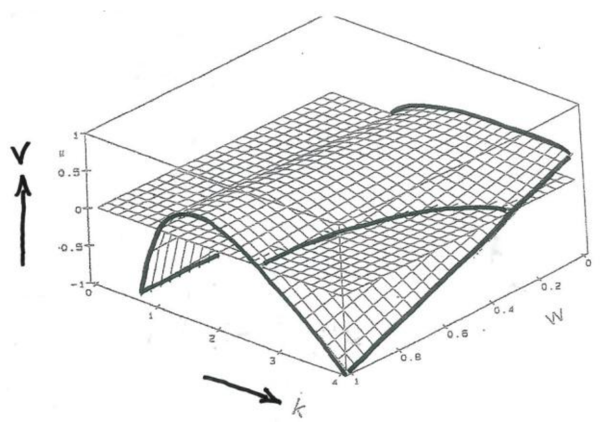

Figure 3 The unstable Ecological Hierarchy, in case of decreasing number of mutations

This will trigger a debate in the technostructure about who is to blame. The last couple of years especially the banking world got the blame in such a debate. It is almost inevitable that there will be some changes in the leadership as a result. Some outsiders will attain a position in which they can realize their dreams or speculations. A few will succeed, thereby introducing a recovery of the economy[5]. A new revolutionary event occurs and a new normal science will grow from that day on. This has happened several times in the last 200-250 years. There are about five typical occasions. They created the long wave in economic life. We can say that h includes a very important dichotomy. So, speculation has a high 'potential' value in the economy. However, in reality,

Sustainability in S.G. Karsten, The US Economy in the light of Justice, Solidarity and Complementarity, West Georgia College.

[4] Noort, P.C. van den (1995). Equilibrium and Complexity, Studies in Chaos Theory, Wageningen Agricultural University (06022302)

[5] Duyn, J.J. van (1983). The Long Wave in Economic Life, London.

only a few may engage in speculations. Most are flexible young scientists or old hands who become interested in new problems, even venturing beyond their usual field of interest. The reward system deters almost all other scientists. In business a career can be damaged by defiant interests or by wrong speculations. So it is best to play safe!

4. Summing up.

The reward system in science may be adapted (especially in the field of publication), to give more room for speculation in science and technology. A complete change, however, is not feasible. We must hope that speculation is given enough space to live, because the activity of so-called mavericks and outsiders is crucial for the recovery after each depression. These outsiders are, so to speak, the economic reserves or the lifeboats of our economic system.

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Summary of data about Kondratieffs

ASPECT	I	II	II	IV	V
	Early mechanisation	Railways[1)]	Electrical[2)]	Mass production	Informatics
Prosperity	1782-1802[3)]	1845-1866[4)]	1892-1913[5)]	1948-1966[7)]	-
War	1802-1815	-	1913-1920	-	-
Recession	1815-1825	1866-1872	1920-1929	1966-1973	-
Depression	1825-1836	1872-1883	1929-1937[6)]	1973-1980	-
Recovery	1836-1845	1883-1892	1937-1948	1980-1989	1990
Innovations	- Textiles - Potteries - Iron	- Steam engines - Railway equipment - Shipping	- Electrical and heavy engineering	- Cars - Durables - Armaments	- Computers - Software - Telecommunication
Key factor industries	- Cotton - Pig iron	- Coal - Transport	- Steel	- Energy	- Chips
Other fast growing industries	- Steam engines	- Steel - Electricity - Dyestuffs	- Cars - Aircraft - Radio - Oil	- Computers - Radar - Airways - Software	- Biotechnology - Fine chemicals
Names of some innovators	- Arkwright - Wedgwood - Owen	- Stephenson - Whitworth - Brunel - Singer	- Siemens - Carnegie - Nobel - Krupp - Edison	- Ford - Agnelli - Mashushita	- Kobayashi - Benneton - Barron
Names of some economists	- Smith - Say	- Ricardo - List - Marx	- Marshall - Pareto - Veblen	- Keynes - Schumpeter - Kalecki	- Schumacher

1) Also 'Bourgeois-Kondratieff'
2) Neo-Marcantilist Kondratieff
3) Industrial Revolution
4) Victorian Prosperity
5) Belle Epoque
6) Great Depression
7) Growth and Full Employment

Sources: Freeman (1988), Keus & de Ridder (1990)