Logistic growth

Growth may be expected to become restricted: growth decreases if we attain a higher production level. The typical aspect of production (Y) is its logistic growth over time (t). We can formulate this as:

$$Y_{t+1} = kY_t - bY^2_t \qquad (1)$$

Growth depends on the coefficients k and b. By setting y = Y.k/b we obtain the standard logistic growth curve:

$$y_{t+1} = ky_t - ky^2_t \qquad (2)$$

in which y is between 0 and 1 and k between 0 and 4. There are clear examples of the sigmoidal curves of this equations in nature, technology and economy[1)].

Logistic evolution

In nature there are mutations. As a consequence, new types with a higher k-coefficient sometimes emerge in a population and oust the old types. A similar process also occurs in the economy, but we prefer to speak of innovations instead of mutations. The idea is, however, equivalent. The k-value of some production processes may increase.

Instability

Because of this rise in k-value our destiny changes, without us immediately being aware of this, because for k > 3.2 we see instability in the former stable sigmoid curves and these fluctuations increase with growing k. When k = 4 there is complete 'chaos'. Instability is dangerous, because competitors exploit the situation and conquer the market; the larger the k-value the greater the danger (see figure 1).

In reality we do not always see this instability. Sometimes the situation is very stable, even though k is rather high; for example, if there is a stream of innovations which enable newcomers to grow where the old types would have suffered a setback. The stream of innovations produces stable growth.

Vitality

We can say that a population is viable if it has high vitality. This vitality depends on the degree of growth, the carrying capacity, the degree of competition, the number of mutations, the resistance to disadvantageous conditions, and stability. The concept of viability can also be applied to types of production or industries, though it is difficult to take account of the many aspects involved (and their different dimensions). It is a problem of comparing like with unlike. We can overcome this problem by using index numbers, and weighting each of the products in accordance with its 'importance' to viability.

The vitality of a population or a production process (industry) depends on aspects such as size and stability. We know that size (quantity) and stability both depend on the value of k (are functions of k), but that they cannot be added directly. The solution is to use an index number of vitality (N):

$$N_o = W * \text{quantity} + (1-W) * \text{stability} \qquad (3)$$

Stability is especially important if k is high and there are no mutations (or innovations). This becomes increasingsly important as the number of competitors increases. We can combine all these aspects in the Newell index[2]:

$$N = \frac{hw\ (k-1)\ (2.6 - k) + (1-hw)\ \log k}{k} \qquad (4)$$

The part log k has to do with growth of the population (or of production). The resistance to deterioriating conditions is equal to the b-coefficient in equation (1) and is a function of 1/k. Hence k is the denominator. The stability is indicated by the part (k-1) (2.6-k). If k has a value between 1 and 2.6, the population (or production process) is very stable, but this is not the case for other values of k. There are two values for h, e.g. h = 0 if there is an abundance of innovations and h = 1 if there are zero innovations. If h = 1 the situation is not stable for high k-values and becomes more unstable as the number of competitors increases. This number of competitors is indicated by w. The greater the value of w, the more detrimental the lack of innovations.

Figure 2. Newell index for h = 0 (a stream of innovations is available). We see the traditional picture of evolution.

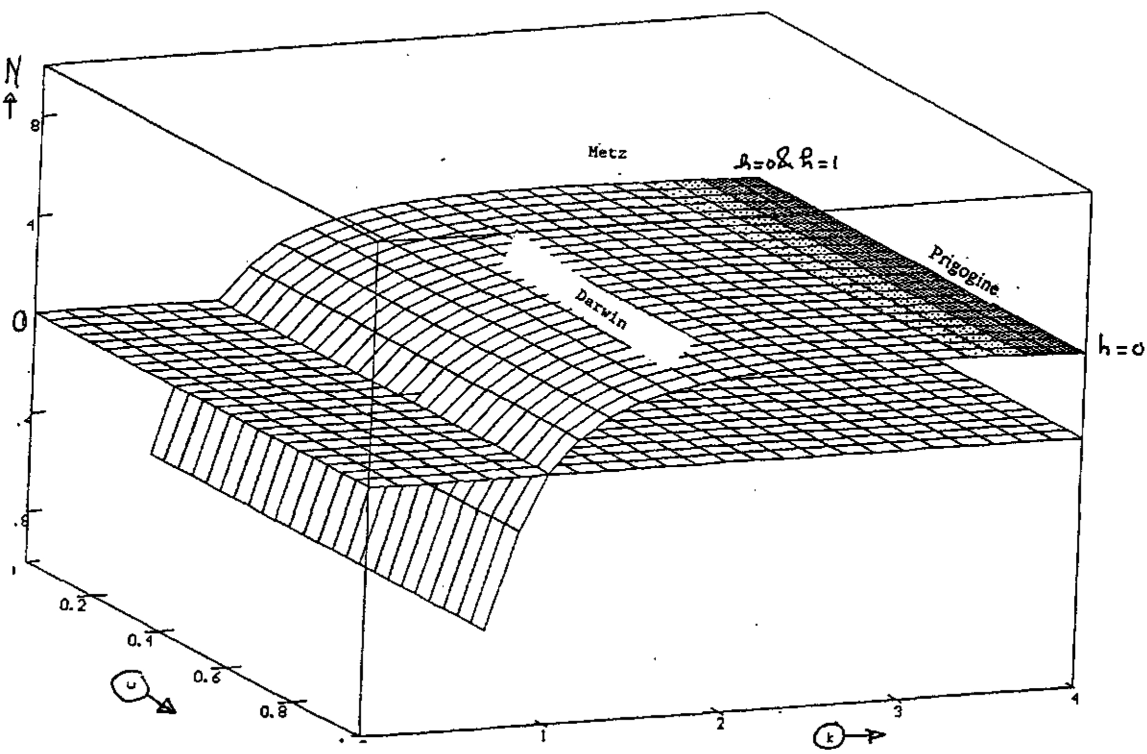


Figure 3. Newell index for h = 1 (no innovations). The mountain caves in.

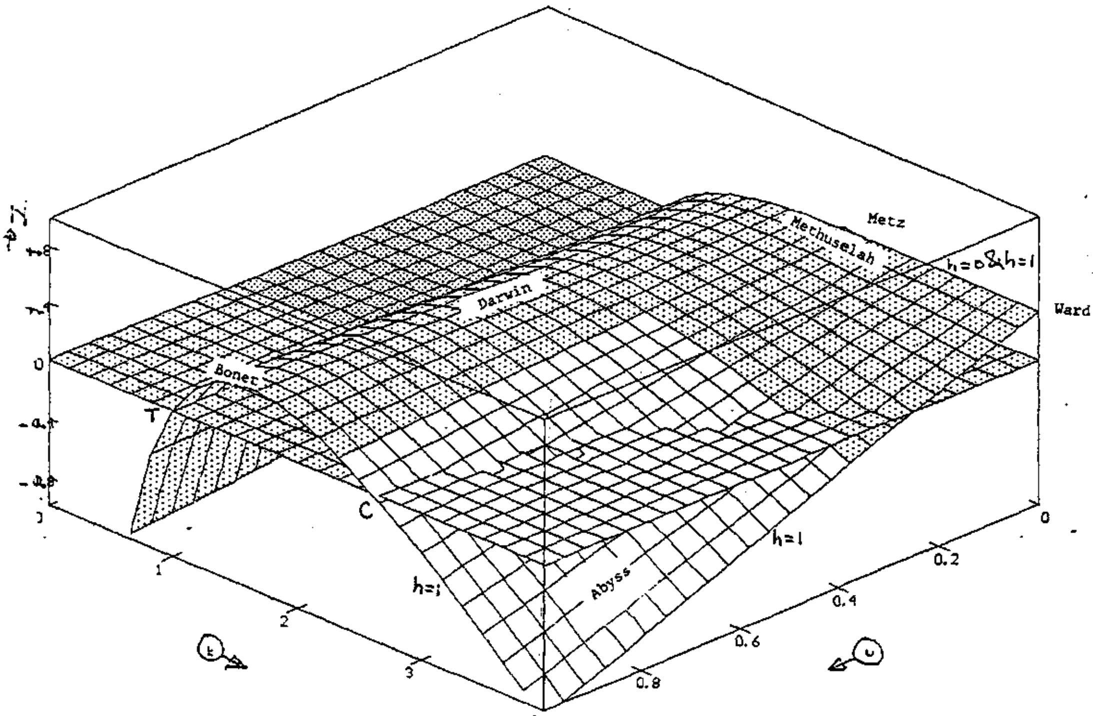
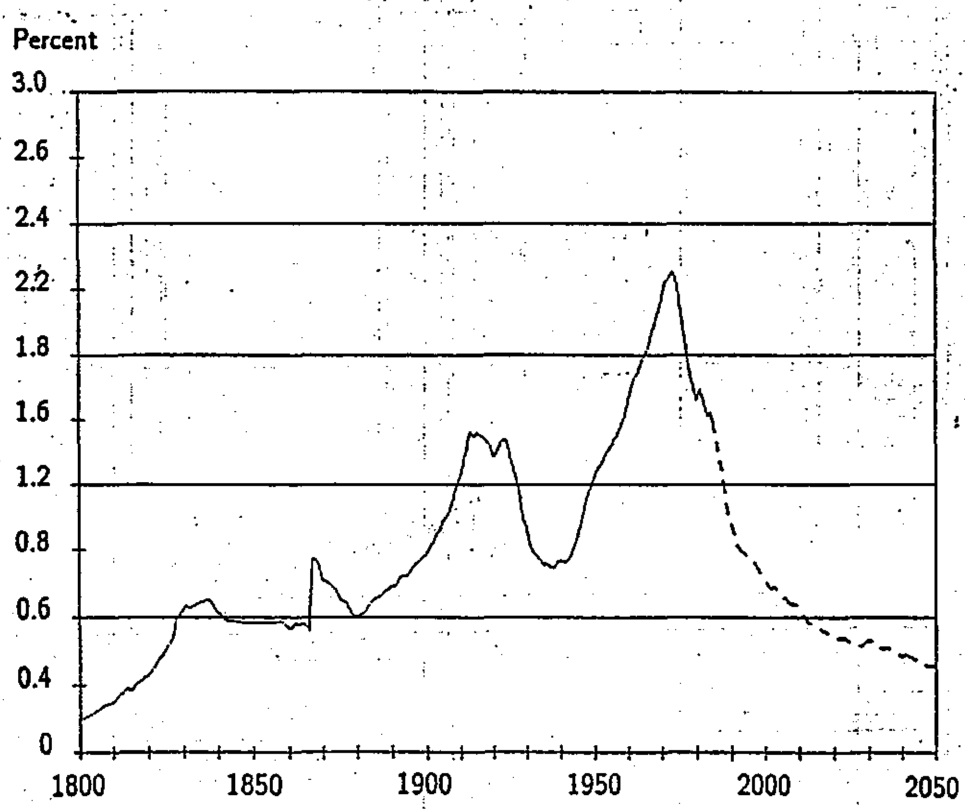


Figure 4. Rate of innovation in the US economy: past and in the near future.



A picture of vitality

Figure 2 depicts the Newell index for situations with an abundance of innovation (h=0). The rising curve is clear - it is a picture of the traditional idea of evolution. We have climbed this mountain of evolution. Many now believe we have climbed enough: we should halt and stay put, or, in other words, we should apply zero growth. We no longer need ever-increasing growth curves or innovations. But opting for zero growth and zero innovation will have a most unexpected effect.

The lack of innovations will lead to instability and this may be fatal for the population. We can see this by setting h = 1 in figure 3; the mountain caves in because part of the index N falls below zero. This is a true extinction of that way of production. Only those types of production that have low k values survive, the others become extinct like dinosaurs. There is one exception, for low w-values (no competition): figure 3 shows that some high k-value populations may survive there. This explains why companies try to corner the entire market (no competitors) or try to innovate all the time. Innovation is very important: without a stream of innovations the economy caves in. This can be illustrated by statistical data from Schumpeter, Grübler, Silverberg and Van Duyn[2]; see figure 4.

Competition

Competition is important in the vitality of industries. There are various types of competition. Some are already operating in the phase of 'ideas' or in the planning phase, others emerge once there are real products or technologies. We then see rivalry between the innovations; one will win out, but will then face competition from outside (other products and services). Various battles may influence the rate of growth. We may even expect revolutionary changes. From the studies of Kuhn and Mulkay[4] we know that the acceptance of new ideas is a complicated process in which 'revolutions' in the power structure of the scientific community play a role. So we not only have to deal with 'stoppages' in the process, but also with 'goes', both depending on the psychological and social factors that govern the acceptance of new ideas in science, industry and government. These revolutions may play an important role in the explanation of the Kondratiev cycle. We must also expect some periods of conservative policies (what Kuhn calls 'normal science') which may ultimately result in h = 1, causing the whole process to grind to a halt.

The process of progress also has disadvantages. First, there are the victims of the revolutions and of competition, and second, the systems will become potentially more unstable. This may result in more cartel policies, more agricultural price policies, more social security, and even in direct subsidies to industries. All this can only be paid for if the system continues to function; if it comes to a halt many of these social niceties fade away, because national income decreases. Massive direct subsidies may even result in industries disappearing, (because of the increasing k-value, see figure 3: an increase from 2.6 to 3.4 would bring total disaster, if h = 1).

Conclusions

Those who innocently advocate zero growth or zero innovation tend to forget the importance of instability. If we want sustainability we must, of course, prevent disasters as in figure 3 and therefore must try to ensure an unfailing stream of innovations. If there is no such stream, the most developed part of the economy will collapse, with disastrous consequences for the economy as a whole. Thus, growth and innovation do not run counter to sustainability. On the contrary: without growth and innovation there will be no sustainability; even the absence of innovations for short periods of time has negative consequences (depressions). From this it is clear that in highly developed economies sustainability will be impossible if the economy stays still as a consequence of the application of zero growth or of zero innovation policies.

Notes

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[3] T.S. Kuhn. The structure of scientific revolutions. Chicago, 1970.
M.J. Mulkay. The social process of innovations. London, 1972.

[4] N. Hall (ed.). The New Scientist guide to chaos, London, 1991, pp. 84 and 176.

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