

***Chreods, path-dependence and evolution:  
chance and necessity in economic development  
(simulation study)***

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Is it necessary to postulate ‘extra’ mechanisms beside well known evolutionary mechanisms of *natural selection* and *novelties generation* to explain such phenomena as path dependence and lock-in?

**Ockham's razor**

(*Occam's razor, also called law of economy, or law of parsimony*)

William of Ockham (1285–1347/49)

„One should not increase, beyond what is necessary, the number of entities required to explain anything”.

Original Latin:

“Pluralitas non est ponenda sine neccesitate”

“Frustra fit per plura quod potest fieri per pauciora”

“Entia non sunt multiplicanda praeter necessitatem”

“Plurality should not be posited without necessity.”

“Entities should not be multiplied unnecessarily.”

Ernst Mach called Occam's razor the *Principle of Economy*:

**“Scientists must use the simplest means of arriving at their results and exclude everything not perceived by the senses.”**

“The best explanation is as simple as possible, but no simpler.”

Albert Einstein

“Seek simplicity ... and then distrust it!”

Alfred North Whitehead

## Path dependence, increasing return and lock-in

Paul David (e.g., 1985, 1995, 2001)

Brian Arthur (e.g., 1989, 1990, 1994, 1996)

Stan Liebowitz Steve Margolis (e.g., 1994, 1995, 1996)

Paul David path dependence – non-ergodic systems

*“Path dependence ...., refers to a dynamic property of allocative processes. It may be defined either with regard to the relationship between the process dynamics and the outcome(s) to which it converges, or the limiting probability distribution of the stochastic processes under consideration.”* (David, 2001).

Brian Arthur, distinguishes between "conventional economics," which largely avoids increasing returns or path dependence, and the "new" "positive feedback economics," which embraces them

Brian Arthur's (1989) – path dependence - “lock-in by historical events.”  
people get "locked-in" to the inferior standard

Diminishing returns dominates ‘classical economies’

Increasing return dominates in high-tech industries

“Is the theory of increasing returns still controversial?”, Arthur answers:

“Absolutely not. This is now completely taken for granted in Silicon Valley.”

The standard examples of path-dependence are QWERTY story (as an inferior alternative to Dvorak keyboard), the VHS-Beta story, DOS computers vs. Apple’s ones.

*“... confluence of network effects, increasing returns, and market outcomes may be spurious. Although many technologies have tended to evolve into single formats (e.g. home-use VCRs are almost all of the VHS variety) some portion of these may actually have evolved for reasons having little to do with either network effects or increasing returns. We should not be surprised to find that where there are differences in the performance of various standards, one may prevail over the others simply because it is better suited to the market.”*

(Liebowitz, Margolis, 1998a)

## Chreods and contingency

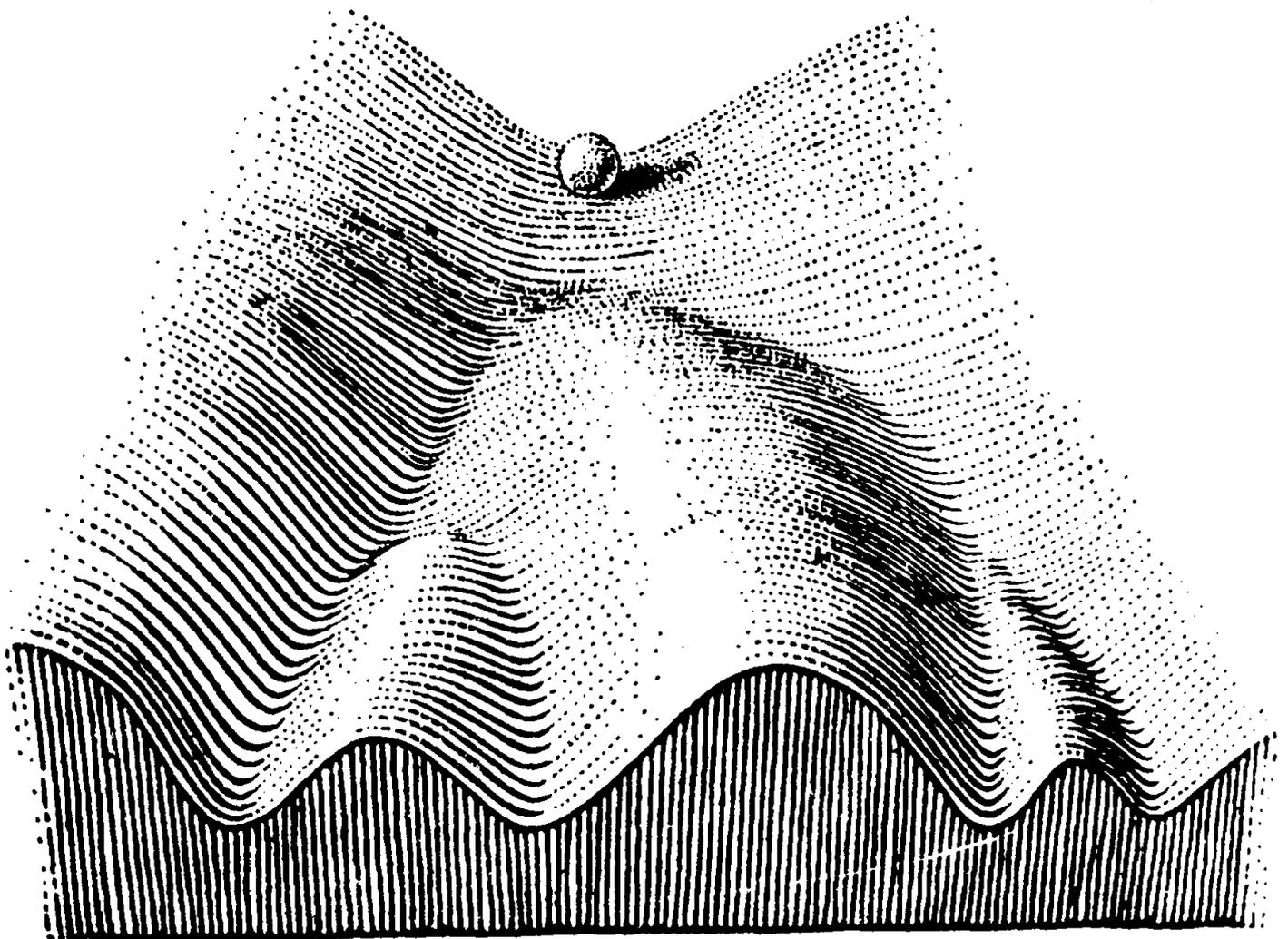
physics and mathematics – chaos theory.

biology – contingency; the irreversible character of natural selection. (Gleick, 1987, Gould, 1991), Mokyr (1991)

biology - necessary path (or chreod); Conrad Hall Waddington (1905-75)  
*Principles of Embryology* (Waddington, 1956, p. 412)

“developmental reactions...are in general canalized. That is to say, they are adjusted so as to bring about one end result regardless of minor variations in conditions during the course of the reaction.”

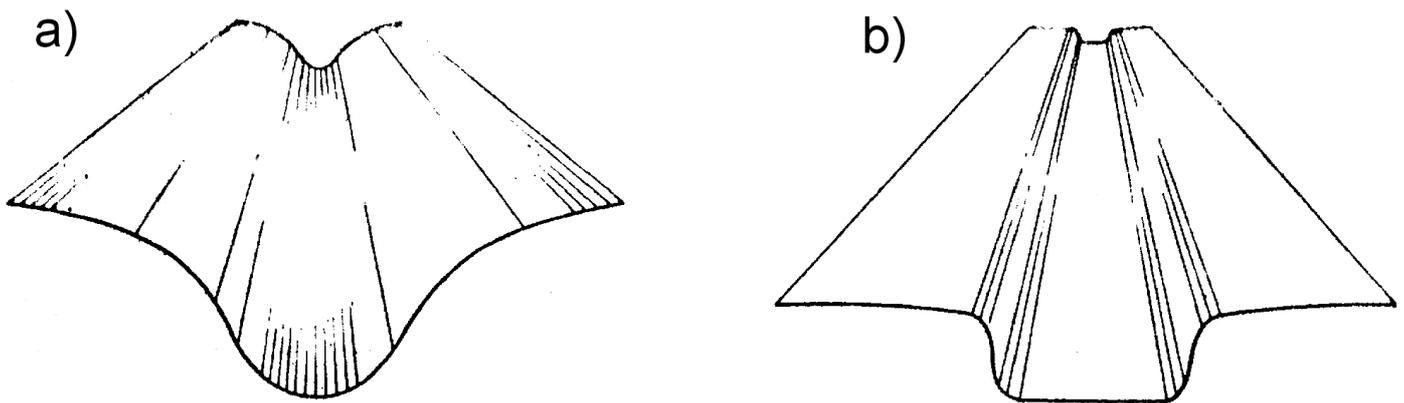
(Waddington, 1941)



*Epigenetic landscape and chreods*

## homeostasis vs. homeorhesis

“The stabilization of a progressive system acts to ensure that the system goes on altering in the same sort of way that it has been altering in the past. Whereas the process of keeping something at a stable, or stationary, value is called homeostasis, ensuring the continuation of a given type of change is called homeorhesis, a word which means preserving a flow. A phrase used to describe such systems, is to say that the pathway of change is canalized. For the pathway itself one can use the name chreod, a word derived from Greek, which means ‘necessary path’. (Waddington, 1977)



*Chreods with different types of stability (Waddington, 1977)*

## Simulation

The relationship between routines and technical characteristics:

$$z_d(r) = c_{d0} + \sum_i c_{di} r_i \quad \text{for } d= 1, 2$$

unit cost of production and productivity of capital - the modified linear transformation of routines

$$V(r) = v_0 e^{-b \left| \sum_i v_i r_i \right|}$$

$$A(r) = a_0 \left| \sum_i a_i r_i \right|^c$$

$a_i$  and  $v_i$  are assumed to be constant in all simulation runs and values of  $a_0$  and  $v_0$  are calculated to assure the assumed initial values of unit cost of production and productivity of capital.

*Table 1. The values of parameters of routines' transformations*

	$v_i$	$a_i$	$c_{1i}$	$c_{2i}$
$r_1$	0	-4	0.15	-0.1
$r_2$	8	0	0.0	0.1
$r_3$	-8	-3	0.07	0.0
$r_4$	-5	6	0.06	0.0
$r_5$	-4	-9	0.05	0.15
$r_6$	4	3	-0.08	0.1
$r_7$	1	-5	-0.1	0.1
$r_8$	0	7	-0.1	-0.1
$r_9$	-9	5	0.1	-0.1
$r_{10}$	7	-1	-0.15	0.07