Self-organization Through Decoupling*

ROMAR CORREA[†]

Department of Economics, University of Mumbai, Vidyanagari, Mumbai 400 098, India

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In one line of research, the transition from Fordism to flexible specialisation is explained by the infeasibility of a mode of regulation that relied on central controls. According to another explanation, which we favour, the disintegration of vertically integrated production is unpredictable. The concept of self-organization is often recommended to model the transition from hierarchical organizational forms to flatter structures. Formally, a conditionally stable nonlinear system of differential equations is examined. In the first thesis, the characteristic roots with positive real parts play the role of ‘order’ parameters which can become unstable modes. The rest of the variables refer to stable modes. The strategy is to show that the stable modes can be expressed in terms of the unstable modes so that the former can be eliminated from the system. On the other hand, we provide a theorem showing that a coupled set of differential equations can become uncoupled and *vice versa* as an argument in favour of the second thesis. The path of evolution can turn both ways.

Keywords: Self-organization; Industrial divides

1. INTRODUCTION

Many theoretical frameworks seek to encapsulate the paradox within capitalism between its inherent tendency towards change and its ability to stabilise around an ensemble of institutions. One such sophisticated account is that provided by the French regulation school. A key concept here is the ‘mode of regulation’ which refers to the organizational forms which secure capitalist production. The passing ‘regime of accumulation’ is

Fordism. As a mode of regulation, Fordism entails the separation of ownership and control in large corporations with a multi-divisional organization subject to central controls. Strategic planners at company headquarters allocate investments among current businesses. The division of labour has to be closely policed (Sabel, 1994). Supervisors made sure workers obey the rules and the former, in their turn, are monitored by the quality-control division.

Such a mode of regulation is only feasible if the massive costs of building such organizations can

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[†]e-mail: romar77@hotmail.com

be amortised over large production runs. This became problematic in the wake of the shocks to the industries in the seventies that dramatically raised the level of pure uncertainty in markets. The rise of innovation and knowledge-intensive manufacturing technologies favoured small batch production. The initial response was to turn to subcontracting and outwork. Subcontractors began by occupying specialised market niches. Product variety began to supplement product differentiation. Industries began to constantly alter their products in response to changing tastes and in order to expand their markets. Either the outputs were changed by altering the input mix or firms themselves changed the outputs. Further, in order to ensure that items selected by the market could be manufactured in time to meet the demand, the costs of hierarchical organization had to be cut. Conception and execution had to be reintegrated. In the new mode of regulation, workers and subcontractors become partners in production. Strategic planning at headquarters tends to vanish. Erstwhile finance and purchase executives are either eliminated or become part of new work teams. Central research laboratories are dismantled as operating units construct their own facilities. The system becomes vertically disintegrated. Diversified quality production puts a premium on competition and cooperation between firms at the same level of the production chain and close, privileged and trust-based cooperation at different levels. These horizontal inter-industry relations offset some of the risks faced by supplier firms and encourage specialisation.

Industrial divides are not induced by marginal alterations in circumstances but require fundamental changes in institutions so that the basic possibilities for the division of labour are altered. It is important to recall that Fordism and other modes of production are structurally stable (Boyer and Durand, 1997). No company can benefit from violating the extant principles of production since that would threaten its profits. By definition, no alternative organizational form adopted by a small number of firms would be capable of displacing

the prevailing system. It is clear, therefore, that a mainstream industrial organization approach to modelling such change would be inadequate, founded as it was on the neoclassical principle of individual optimisation. Consequently, many theorists have advocated the use of systems theory and the theory of self-organization to model the evolution of organizations in terms of the aggregate, unintentional outcomes of actions (Dosi, 1995; Jessop, 1995). In what follows, we use systems theory to argue that the evolution of organizational forms is unpredictable because the specific environments in which agents make decisions are characterised by radical uncertainty. It is unnecessary to hypothesise that the discontinuous transition from multi-level firms to leaner structures is the result of the infeasibility of boss-worker interactions.

In the language of systems theory, firms are open systems which are characterised by a continuous exchange of elements with their environment. This exchange forms the basis for their survival. The environment consists of all phenomena that exert a direct influence on the firm and which, in turn, are affected by it. For instance, no matter how high the internal efficiency of a firm its existence depends in no small measure on its external efficiency. It is postulated that the rate of environmental change is so rapid that increasingly the past becomes a poor guide for the future. It cannot contribute scientific or probabilistic rules of conduct because it differs from the present in ways that are identifiable and significant. Thus, it is common to see the rational strategies of planned innovation and long-range planning of firms being undermined by unpredictable changes.

An equilibrium in critical exchanges with its environment can only be obtained if the firm evolves certain features of organization and information exchange with the environment. One path taken is the movement in the direction of a hierarchical decomposition of functions. Systems grow by means of elaboration and differentiation and the more complex they get the greater their decomposability. The multidivisional structure of

the modern corporation can be regarded as an illustration of this evolution (Williamson, 1983). This structure grew out of the earlier unitary form wherein senior management was involved both with immediate routine decisions as well as with long-range planning and investment activities of the firm. In the new structure they are relieved of day-to-day current duties and are left free to ponder over critical choices like the acquisition of capital. On the other hand, Kay (1979, 1982 and 1984) using systems theory to show how firms frame strategies to cope with environmental uncertainty, arrives at the opposite evolutionary possibility. If individual subsystems can be decoupled from the overall system without threatening the integrity of the latter a basis of system design in the face of fundamental uncertainty can be found. The decomposability of a conglomerate strategy based on unrelated product markets means that divestment of old divisions could be undertaken without any concern for the relationship of the parts to the whole. The open systems idea is also the common ground in the various branches of modern evolutionary economics (Hodgson, 1996; Witt, 1996). Systems are believed to evolve through the generation and dissemination of novelty. One important source of novelty is creativity and real choices. These in turn entail that human actions contain an element of indeterminacy. Systems contain, in embryo, the capacity to produce a variety of forms.

In the next section, the two hypotheses about the breakdown of hierarchical structures are examined in a formal framework. A final section is by way of conclusion.

2. SELF-ORGANIZATION THROUGH DECOUPLING

The science of self-organization considered here has been called synergetics by Haken (1977, 1987). Synergetics deals with systems composed of many subsystems. It studies the means by which the cooperation of these subsystems results in

temporal or functional structures on a macroscopic scale. The basic ideas are illustrated by means of an economic illustration by Haken. Consider a group of workers. Their behaviour is said to be 'organized' if each acts in accordance with orders given by a boss. The same production would be called 'self-organized' if it was not subject to external orders but the work was distributed among the individual workers in parallel.

Formally, a nonlinear system of differential equations is given, that is,

$$\frac{dx}{dt} = Ax + f(x)$$

where x is a n -vector and $f(x)$ is a vector whose elements are polynomials in the components of x . Variables that 'slave' subsystems are called 'order' parameters. Some of the characteristic roots of A have negative real parts and the rest have positive real parts. The roots with $\text{Re}\lambda_i \geq 0$ play the role of the 'order' parameters which can become unstable modes. The rest of the variables refer to stable modes. In the familiar language of ordinary differential equations, the characteristic roots of A are assumed to be real and distinct. If there are any characteristic roots of A with negative real parts, then the solution $x=0$ possesses a certain conditional stability (Bellman, 1953; Coddington and Levinson, 1955). To obtain solutions of the system which approach zero as $t \rightarrow \infty$, the elements of $x(t)$ which do not tend to zero as $t \rightarrow \infty$ must be weeded out.

We do not require such a division of characteristic roots. The focus is entirely on the function that couples the various components of x . To that end, assume that the matrix A is already in diagonal form with characteristic roots along the main diagonal. The system is given by

$$\frac{dX}{dt} = AX + F(X)$$

where X is a diagonal matrix with the components of x along its main diagonal and $F(X)$ is a diagonal matrix with the components of $f(x)$ along its main

diagonal. It will be shown that there exists a transformation of the function F such that the system can be decoupled into n real nonlinear functions $x_i = g_i(\lambda_i)$, $i = 1, \dots, n$. For the system defined above,

THEOREM *There exists a polynomial matrix $P(\lambda_i I)$ such that $F(X) = P(\lambda_i I)$.*

Proof Perform the transformation

$$yx = \lambda_i$$

where y is a n -vector and λ_i are the characteristic values of the matrix A . Thus,

$$YX = \lambda_i I$$

Introduce two square matrices $B(\lambda)$ and $C(\lambda)$ whose diagonal elements are polynomials such that

$$B(Y)F(X) = C(\lambda_i I)$$

$B(\lambda)$ is assumed to have a constant non-zero determinant. The inverse matrix $D(Y) = B^{-1}(Y)$ is also a polynomial matrix. The equation above can be written in the form

$$F(X) = D(Y)C(\lambda_i I)$$

By the Generalised Bézout Theorem (Gantmacher, 1959)

$$F(X) = [D(\lambda) - Q(\lambda)(\lambda I - Y)]C(\lambda_i I)$$

where $Q(\lambda)$ is the quotient of $C(\lambda)$ on division by $\lambda I - Y$. Note that the usual distinction between the right quotient and the left quotient and right value and left value of the polynomial do not apply as all the matrices of concern are diagonal matrices.

$\lambda_i I$ and Y are obviously similar, that is, there exists a non-singular matrix T such that

$$Y = T^{-1}(\lambda_i I)T$$

$$\therefore \lambda I - Y = T^{-1}(\lambda I - \lambda_i I)T$$

Substituting,

$$F(X) = \{D(\lambda) - Q(\lambda)[T^{-1}(\lambda I - \lambda_i I)T]\}C(\lambda_i I)$$

Denote the right hand side of the above expression by $P(\lambda_i I)$ and the theorem is proved.

3. DISCUSSION

In Haken's scheme, the strategy is to show that stable modes may be expressed in terms of unstable modes so that the former can be eliminated from the system. The presumption is that organization moves in the direction of self-organization. The procedure above, on the other hand, does not rely on two distinct groups of characteristic roots. The transformation matrix therefore does not lend itself necessarily to such an interpretation. Coupled differential equations can become uncoupled and *vice versa*.

4. CONCLUSION

The argument above is nicely consistent with the contemporary view that both evolutionary outcomes are possible. In the magnificent dynamics of Marx and Schumpeter, the emergence of large, hierarchical organizations was regarded as the central mechanism of capitalist control (Piore, 1996). Instead, the present conjuncture is characterised by the reemergence of small firms as critical players not only in new industries like computers and biotechnology but also in traditional industries like steel. There is a fresh emphasis on network organizations and alliances that knit small firms together in larger entities. In terms of the argument of the paper, there is no unique explanation for the transition from vertically integrated production to flexible specialisation (Storper, 1994). The first industrial divide was the outcome of special circumstances. A second divide is now possible because the circumstances have changed. In the organization of the new mode of production, external economies can, at a

certain point, be said to outweigh economies of scale both in production and transaction costs. The existence of strong external economies implies that these outcomes need not be planned by large firms. If, in particular, new technologies are superior at any point of time to existing technologies, the path taken can even be the outcome of random factors. Indeed, vertical disintegration in its inducement to continual diversification of product markets might therefore lead to organizational innovations that resynthesise labour processes and restore vertical integration. For example, flexible automation might lead to vertical integration through economies of scope or to specialization and vertical disintegration.

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