

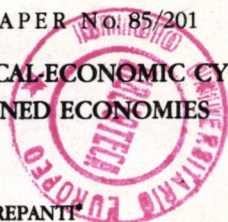
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**A MODEL OF THE POLITICAL-ECONOMIC CYCLE
IN CENTRALLY PLANNED ECONOMIES**

by

Ernesto SCREPANTI



* Professor of Economics, University of Trento. This research was undertaken in connection with the EC-funded project on "East-West Trade and Financial Relations" directed by Professor D.M. Nuti at the European University Institute.

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European University Institute
Badia Fiesolana
- 50016 San Domenico (FI) -
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SUMMARY

This work springs from a model of the political-economic cycle in centrally planned economies recently put forward by Nuti. Nuti's model is briefly evaluated. Then some of his hypotheses are modified in such a way that a new model ensues. The cyclical motion of the economy is taken to depend on the behaviour of two political agents: the Central Committee and the working class. The former manoeuvres the processes of political and economic decentralization and those of political and social control in response to workers' behaviour. The latter depends on the level of economic welfare and that of political control in such a way that catastrophic changes can occur, generating explosions of political unrest. As authorities react to unrest by increasing their grip over the political and economic systems, and as changes in centralization levels affect the factors of workers' behaviour, a cyclical process of social unrest, economic disease and political centralization may ensue. Whether this possibility comes true depends basically on the economic efficacy of decentralization. If this is high, a virtuous circle of economic growth, social peace, welfare increases and political and economic decentralization is activated. If it is very low, a vicious circle is activated in which economic diseases, political anarchy and centralization moves sustain each other. A cyclical movement obtains for intermediate levels of decentralization efficacy.

A model of the political-economic cycle in centrally planned economies (*)

E. Screpanti

1 - Introduction

Where economic decisions are taken by a central political authority in the name of the working class no collective manifestation of workers' grievances can be tolerated.

In a system like that any economic cycle can be only the result of an "immanent dialectical sequence" "in the internal competition for social control" (Olivera, 1960, 244, 245). Yet very few students have been able to study the economic dynamics of the East European countries as "psychological and political processes" (Bajt, 1971, 62) in which "such factors as rapid shifts in economic policies, changes in organization and planning techniques, political unrest, overambitious goals" (Staller, 1964, 394) play a fundamental role; and only recently has a fully fledged model of the political-economic cycle in "socialist" systems been developed, by Nuti (1979, 1981, 1984, 1985). These notes

(*) The author wishes to thank W. Bartlett, A. Gay, D.M. Nuti and A. Valli for their comments and criticisms. The usual disclaimers apply.

spring from that model. Nuti's arguments are briefly expounded and commented on in section 2. In the following sections some of his hypotheses are modified. A new model ensues which, though expressing a different philosophy, yields the same results as Nuti's.

2 - Nuti's model

There are three sets of hypotheses.

The first set deals with the political and economic structure of the system and accounts for the transmission mechanisms through which political authorities can affect workers' conditions of life:

- 1) political and economic decentralization go hand in hand;
- 2) any increase in centralization brings about microeconomic inefficiency, shortages, queues and a bias towards capital accumulation with a consequent decrease in the consumption ratio.

The second set of hypotheses deals with workers' behaviour:

- 3) political unrest is fuelled by shortages, inefficiency etc.

Evidently hypotheses 2) and 3) are mediated by two

implicit assumptions concerning the dynamics of workers' conditions of life and behaviour: shortages, low productivity (and wages), decreases in the consumption ratio, etc., worsen workers' welfare; in a system in which no form of legal economic struggle is allowed those factors of discontent tend to result in political unrest.

The third set of hypotheses deals with the authorities' behaviour:

- 4) workers' action, as long as it remains below a certain level, induces the authorities to slacken their grip over the economy and society;
- 5) beyond that threshold, political unrest evokes drastic, authoritarian responses.

In Nuti (1985) the model has the form of a system of linear difference equations; it is used in simulation experiments but not worked out formally. Thus no demonstration sustains Nuti's conclusion that the system can generate three different kinds of change (a peaceful evolution toward "liberal market socialism", a march toward political anarchy and political collapse, an economic and political cycle). Rather the mathematical structure of the model gives the impression of being capable of generating a much greater number than three kinds of change, depending on the values assigned to the parameters, on the structure chosen for the time lags etc. Yet Nuti's conclusions seem sound and deserve to be demonstrated formally as holding under very gener

al assumptions.

To do this the model is reformulated by using some simple tools of "qualitative" mathematics; thus, simulation experiments are prevented but the basic elements of the theory are dealt with in the most rigorous and simple way. However, the modifications introduced are not just formal: some of Nuti's hypotheses are changed substantially, so that the ensuing model seems fairly new.

3 - Structural hypotheses

Let:

W = Workers welfare,

D = (Political) decentralization,

D_e = Economic decentralization,

U = Working-class action (or moods), political unrest,

\tilde{U} = Disequilibrium values of U , individual moods,

\tilde{D} = Disequilibrium values of D .

Hypotheses 1) and 2) are preserved. Political decon-

centralization, economic decentralization and workers welfare are all diffeomorphisms of one another. Formally:

$$(1) \quad W = W(D),$$

with

$$\frac{dW}{dD} = \frac{dW}{dD_e} \frac{dD_e}{dD} > 0, \quad \frac{dD_e}{dD} > 0.$$

This function is a heroic shortcut to represent a very complex and roundabout transmission mechanism between the decisions of the Central Committee and the workers' conditions of life. It could be called the economic efficacy of decentralization function.

Its derivative, the marginal efficacy of decentralization, in itself, has no economic meaning but as the resultant of two structural parameters: dW/dD_e , the marginal efficiency of economic decentralization; and dD_e/dD , the marginal leverage between the economic and political system.

dW/dD_e reveals the degree of autonomy between peripheral economic units and the planning authorities. The higher the level of autonomy, the higher the ability of authorities to activate economic welfare by decentralizing production decisions. For instance, confront two systems differing in the percentage of agricultural production under private control; suppose this percentage is higher in system A than in B. Decentralization could consist in reducing the number of products needing previous authoriza

tion from the planning authorities to be produced. As private producers are prompter than State producers to adapt to market demand this will bring a greater welfare increase in system A than in B.

dD_e/dD reveals the degree of autonomy between the economic and political systems, as measured, for example, by the percentage of economic managers who are not party members. In Soviet-type economies managers pursue not only economic but political targets; or, at least, take care not to oppose targets set by political leaders. Probably managers who are also party members are more prone to identify themselves with party interests and political objectives, while managers excluded by the 'nomenklatura' may regard such objectives as external constraints. A move toward decentralization, e.g. a loosening of political control over management, should enable the second more than the first group of managers to pursue pure economic targets with a higher degree of confidence; therefore, most probably, in a system with a higher percentage of independent managers, a higher increase in overall economic efficiency will result.

In this general and simplified treatment there is very little to be gained from going into detail and it is better to avoid making any distinction between the economics and the politics of decentralization. Assuming linearity, function (1) can be represented as in figure 1.

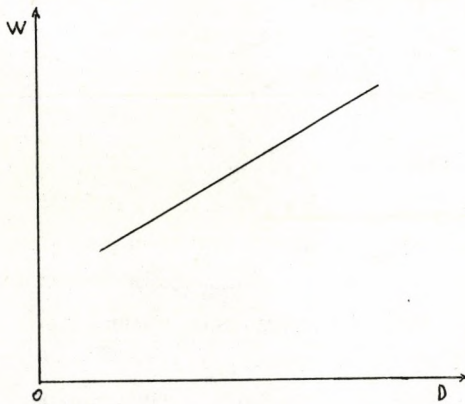


figure 1

4 - Authorities' behaviour

A central committee is a small body of people with a common interest: maintenance of power; which, in the long run, coincides with the maintenance of social order. Nutti's assumption, that the authorities first react positively (i.e. by decentralizing) to political unrest and then, when this rises above a certain threshold, overreact negatively, seems to account for some recent historical occurrences; however it does not seem a general assumption. Actually, most probably a positive reaction should fuel further unrest, so the negative reaction would always come too late to keep workers under control. Such behaviour is destabilizing from the viewpoint of the overall system and irrational from the viewpoint of the au-

thorities' interests.

The central committee should be assumed to possess a sufficient amount of instrumental rationality. This means that it knows the rhythm of decentralization (economic liberalization, political democratization, police repression etc.) capable of balancing any specific level of political unrest and economic anarchy in the long run and that it knows how to adjust to any rapid variation in these variables; which makes authorities play the role of a servo-mechanism regulating the effects of workers' action on the working of the system.

In other words there should be at work a long lasting equilibrium (or, rather, equilibrating), relationship between workers' action and the rhythm of decentralization; such a relationship, by virtue of the assumption of instrumental rationality, should be monotonically decreasing; there should also be a fast adjustment mechanism to variations in the two variables; finally, a neutral level of workers' action should be defined, above (below) which authorities tend to decrease (increase) decentralization (*).

(*) If \hat{U} measures workers' action and \bar{U} its neutral level, the variable \underline{U} is defined, through the mapping $\hat{U} - \bar{U} \rightarrow \underline{U}$, such as to bring the neutral level of unrest at point zero.

Formally these arguments yield a function like

$$(2) \quad \frac{d\tilde{D}}{dt} = -p(\tilde{D} - D) - \varphi D.$$

with

$$\varphi = \varphi(U), \quad \varphi' > 0, \quad \varphi(0) = 0, \quad p \gg 0,$$

where p and φ represent, respectively, fast and slow moving coefficients of reaction.

An equilibrium trend of decentralization is defined as the one authorities judge capable of balancing a given level of U . Therefore the equilibrium solution of (2) gives the equilibrating relationship between decentralization and political unrest :

$$(3) \quad D = Ae^{\delta t}, \quad A = \text{constant},$$

$$(4) \quad \delta = -\varphi(U),$$

where $\delta = \frac{dD}{dt} \frac{1}{D}$ is the rate of change of decentralization. D and δ are represented graphically in figures 2 and 3.

Equation (4) describes the slow dynamics of decentralization. In appendix I it is shown that the fast dynamics of \tilde{D} , accounting for adjustments to $(\tilde{D} - D)$, is stable.

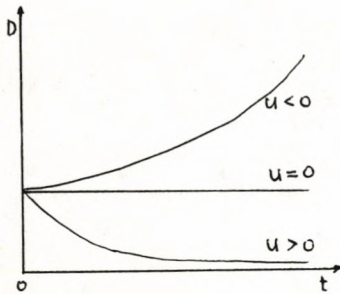


figure 2

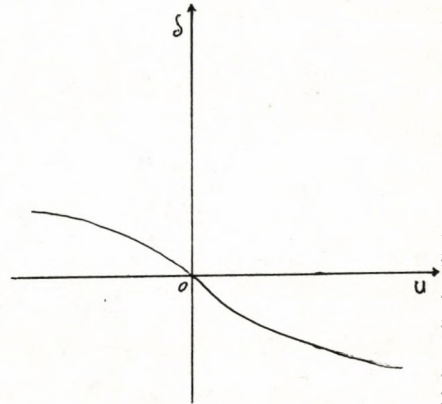


figure 3

5 - Workers' behaviour

Nuti's assumption about workers' behaviour deserve a more accurate reformulation. According to Nuti when shortages, queues, economic inefficiency and the like impair workers' conditions of life there is unrest. Moreover given the normally poor performances (in terms of workers' welfare) of the East European economies and considering that the institutional setting prevailing in those countries enable workers always to lay responsibility on the

State, why workers do not go into something like a perma
nent revolution?

In fact workers' moods also depend on a political factor: the fear of repressive measures by the authorities to dispose of manifestations of discontent. Political repression is strictly related to centralization moves. Therefore workers' moods can be assumed to depend on W and D :

$$(5) \quad V = V(\tilde{U}; W, D) .$$

W and D are conflicting factors of workers' behaviour: an increase in the W is, ceteris paribus, conducive to peaceful moods, while, ceteris paribus, an increase in the D gives leave for more daring behaviour by workers. When both factors are enabled to vary jumps can result; two hypotheses ensure this :

- A given, constant welfare level can bring workers into a peaceful mood only if political decentralization is main maintained below a certain threshold. When the party grip loosens workers' self confidence increases and cumulates, while their "voicing" for welfare improvements rises; if these do not come, eventually workers' discontent explodes.
- A higher (but still constant) level of welfare implies a lower level of discontent, more peaceful behaviour and a higher threshold for social explosion.

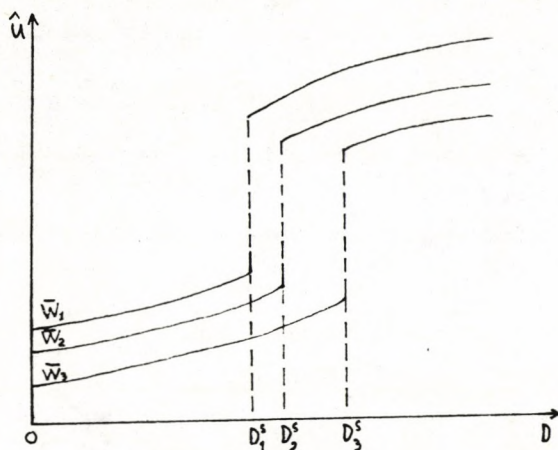


figure 4

In figure 4, a family of relationships between \underline{U} and \underline{D} is shown to correspond to different levels of welfare $\underline{W}_1 < \underline{W}_2 < \underline{W}_3$... Decentralization levels $\underline{D}_1^S < \underline{D}_2^S < \underline{D}_3^S$ represent different thresholds corresponding to those three levels of welfare.

As a change of coordinates has been performed on \hat{U} , it is convenient to transform also the \underline{W} and \underline{D} variables, so that let

$$a = D - W, \quad b = D + W.$$

Equation (5), to embody the two new hypotheses of workers' behaviour, can be specified as :

$$(6) \quad U^3 - bU - a = 0.$$

This is the cuspid catastrophe equation; it determines the equilibrium solutions of a dynamic system accounting for changes in \tilde{U} as depending on \underline{D} and \underline{W} . It is graphically represented as manifold σ in figure 5, where the blank sheets contain attractors, the shaded one repellers. The projection of the fold curve (the boundaries of the shaded area) onto the \underline{W} - \underline{D} plane locates a bifurcation set.

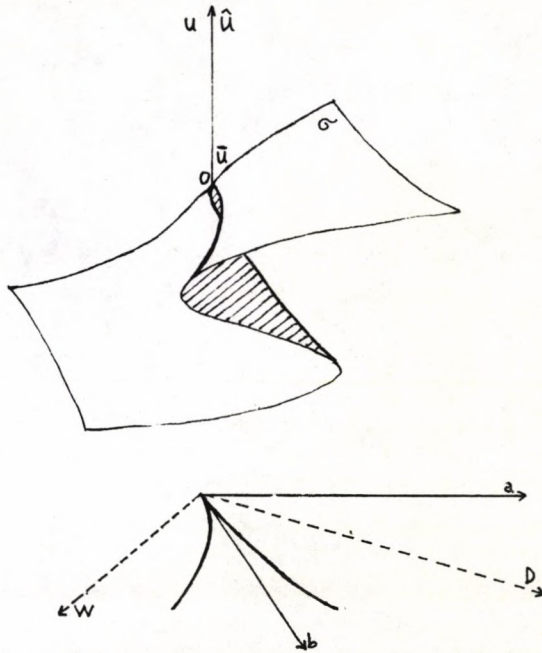


figure 5

In appendix II a greater number of details is given on the meaning of equation (6) and the implied assumption. It is also shown that a stable fast dynamics operates around those solutions of equation (6) represented by the blank sheets of manifold 5.

6 - The working of the model

Now the model is complete. Its slow dynamics is determined by the following three equations :

$$(1) \quad W = W(D) ,$$

$$(4) \quad \dot{S} = -\varphi(U) ,$$

$$(6) \quad U^3 = (D+W)U + (D-W) . \quad \bullet$$

For the moment consider the case in which the slope and position of the W-function in the W-D plane is such that it cuts the bifurcation set as in figure 6.

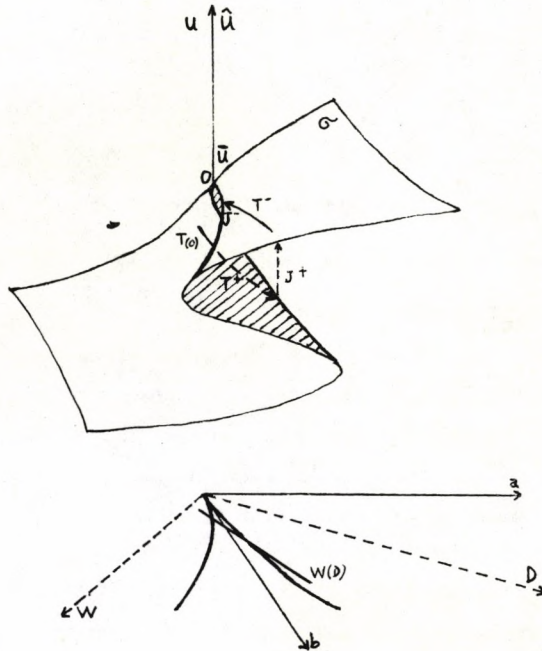


figure 6

Equations (1) and (6) form a system of two equations in the three variables U , D , W . It has many solutions, whose graphical representation is shown by the lifting of the W -function onto manifold G in figure 6. Once a variable is made to vary with time, the slow dynamics of

the system is governed by equation (4). For instance, let the change start from $\underline{D(0)}$, $\underline{W(0)}$, $\underline{U(0)}$, locating point $\underline{T(0)}$ at time $\underline{t=0}$ in figure 6. As $\underline{U(0)} < 0$, $\underline{\delta} > 0$; therefore $\underline{D(t)}$ and $\underline{W(t)}$ increase with \underline{t} . At point $\underline{J^+}$, \underline{U} undergoes a catastrophic jump. The change from $\underline{T(0)}$ to $\underline{J^+}$ is described by trajectory $\underline{T^+}$. After the jump, $\underline{U(t)} > 0$ and $\underline{\delta} < 0$; therefore $\underline{D(t)}$ and $\underline{W(t)}$ decrease. This change is described by trajectory $\underline{T^-}$. When $\underline{T^-}$ touches the fold curve at point $\underline{J^-}$ another jump in the opposite direction will occur after which a new cycle will begin.

Another way of studying the motion of the system is the following. By using $\underline{D=Ae^{\delta t}}$ instead of equation (4), one gets, at any given \underline{t} , a three equation system in the three unknowns. A solution is represented by a point of trajectory $\underline{T^+}$ or $\underline{T^-}$ in figure 6. By letting \underline{t} vary, the solution moves along the trajectories.

The cyclical motion can be represented in a more compact form. Rewrite equation (6) more simply:

$$(6') \quad U = f(W, D);$$

then substitute equation (1) into it :

$$(6'') \quad U = f(W(D), D) = g(D).$$

Equations (6') and (6'') can be represented in the $\underline{U-D}$ plane as in figure 7. The \underline{S} -shaped curves (similar to those drawn in figure 4) are the projections, onto the $\underline{U-D}$ plane, of a fibration of manifold \underline{G} ; i.e. a family of \underline{f} -relations (with \underline{W} taken as a parameter). The parabolic

curve is the projection, onto the $\underline{U-D}$ plane, of the fold curve of figure 5. Finally, the heavy lines are the projections, onto to the $\underline{U-D}$ plane, of the \underline{g} -relation, i.e. of trajectories \underline{T}^+ and \underline{T}^- of figure 6. Simple arrows indicate fast dynamics changes, while double arrows indicate slow dynamics. The dash

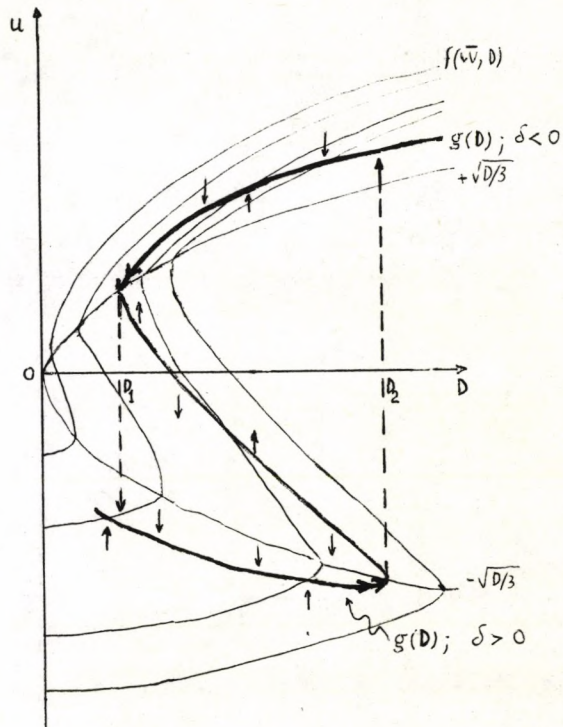


figure 7

ed arrows indicate catastrophic jumps. Relation $g(D)$ is doubly valued (discarding repellors). When $U < 0$, it is $\dot{S} > 0$; therefore the lower arm of $g(D)$ implies a rightward motion. The opposite holds true when $U > 0$. Catastrophes occur when $g(D)$ touches the parabolic curve in figure 7; this happens at D_1 and D_2 .

A still more compact representation can be used. Substitute equation (6'') into equation (4). It results:

$$(4') \quad \dot{S} = -\varphi(g(D)), \quad D_1 < D < D_2,$$

an equation that synthetizes heroically the working of the model, as is shown in figure 8. Being $\dot{S} \leq 0$ if $U \geq 0$, when $U > 0$ D decreases, as is shown by the

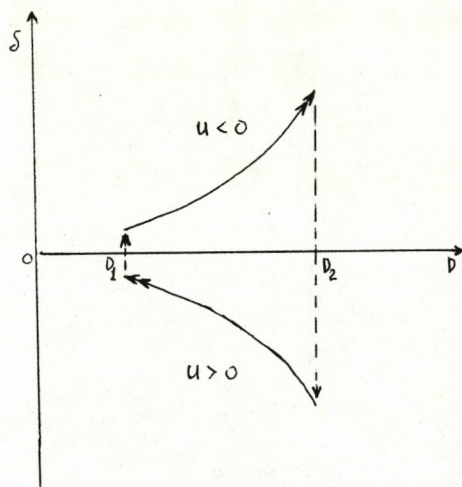


figure 8

lower arrow in figure 8. The opposite holds true when $\underline{U} < 0$. At \underline{D}_1 and \underline{D}_2 catastrophic changes occur.

The cyclical behaviour of the system is due to the \underline{W} -function cutting the bifurcation set as shown in figure 6. If this does not occur no cyclic motion will take place but only permanent growth processes in which decentralization and welfare increase (or decrease) throughout. This is shown in figure 9 and in figure 10.

7 - Conclusions

It goes without saying that the \underline{W} -function is a very stylized shortcut of the possible relationships existing between authorities' decisions and workers' conditions of life. Actually such a function does not need to be strictly monotonic, nor linear. Furthermore it is even sensible to envisage a more or less chaotic fast dynamics around it. In short almost any kind of change in the mix of political and economic liberalization, as well as in its effects on economic performance and social welfare, is possible. Thus the \underline{W} -function can be seen as only the long run trend of those changes. Now, what really matters is the direction of that trend; and all the possible directions can be classified into

three types corresponding to the three positions taken by the W-function in figure 9.

Depending on those positions, three neatly different kinds of change can arise. Consider the three W-functions drawn in figure 9. W₁(D) determines a virtuous circle of selfsustained growth of welfare and decentralization with permanently peaceful workers. The position of W₁(D) implies a high efficacy of decentralization; with a small increase in liberalization it is possible to activate a rapid increase in welfare which makes workers prone to accept the going state of affairs; a social climate establishes itself that feeds positively back into the confidence of authorities and encourages further decentralization.

Function W₂(D) determines the politico-economic cycle already described in figure 6. Such a position of the W-function implies a low efficacy of decentralization. Welfare does not increase rapidly enough to satisfy workers; this urges them to action; at the same time the increase in political decentralization feeds their hopes and reduces their fear: grievances cumulate together with self confidence and eventually political unrest bursts forth. As a result of the explosion the sway toward centralization gains strength. As the system gets tighter, shortages, reduction in consumption ratio, economic inefficiency, slowing down in productivity and wage increases ensue. In these conditions

workers' anger cannot easily subside. However their behaviour must; in fact it will be taken care of by political repression (a by-product of increased centralization). At last, if the State wins the game, a break down in workers militancy, brought about by a political defeat, paves the way to a new thaw.

If this last event does not come true, the system is doomed to move into a vicious circle of political anarchy, military repression and economic collapse, as is implied by function $w_3(D)$.

The resulting three possible time evolutions of \underline{U} are described in figure 10 as $\underline{U}_1(t)$, $\underline{U}_2(t)$, $\underline{U}_3(t)$. \underline{W} and \underline{D} follow similar paths.

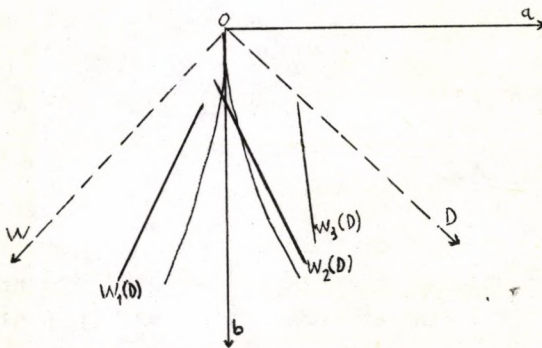


figure 9.

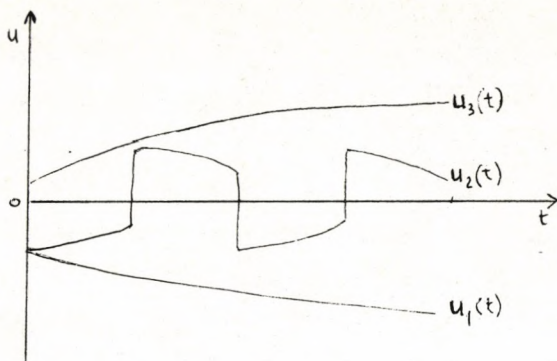


figure 10

Appendix

I - The need to separate fast from slow dynamics suggests specifying the assumption about authorities behaviour thus :

$$(2) \quad \frac{d\tilde{D}}{dt} = -p(\tilde{D} - D) - \varphi(U)D .$$

In equilibrium

$$\tilde{D} - D = 0 ;$$

therefore

$$\frac{dD}{dt} = -\varphi(U)D ,$$

$$\delta = \frac{dD}{dt} \frac{1}{D} = -\varphi(U) ,$$

and

$$(3) \quad D = Ae^{\delta t} , \quad A = \text{constant} .$$

The meaning of equation (2) is that the equilibrium level of decentralization varies as a negative function of \underline{U} , while its disequilibrium changes adjust

the discrepancy $(\tilde{D} - D)$. When \underline{U} settles at a given level, \underline{U}_1 , authorities are satisfied with $\underline{\delta}_1 = -\varphi(\underline{U}_1)$, or $\underline{D}_1 = Ae^{\delta_1 t}$. When \underline{U}_1 transforms into \underline{U}_2 , \underline{D}_1 becomes a disequilibrium value, \tilde{D}_1 , and the authorities adapt rapidly to the new value \underline{D}_2 by reacting to $(\tilde{D}_1 - D_2)$.

It is easy to see that equation (3) is a stable solution. Equation (2) can be rewritten

$$(2') \quad \frac{d\tilde{D}}{dt} + p\tilde{D} = (p + \delta)Ae^{\delta t}.$$

Defining

$$\tilde{\tilde{D}} = \tilde{D} - D,$$

it is

$$(7) \quad \frac{d\tilde{\tilde{D}}}{dt} + p\tilde{\tilde{D}} = 0$$

and

$$(8) \quad \tilde{\tilde{D}} = Be^{-pt}, \quad B = \text{constant}.$$

Therefore

$$(9) \quad \tilde{D} = \tilde{\tilde{D}} + D = Ae^{\delta t} + Be^{-pt},$$

which is stable around the equilibrium trend if $\underline{p} > 0$.

II - Workers do not possess a permanent central committee and cannot act strategically. They are a collective agent; a class of individuals. Their behaviour as a class must result from some elementary process of aggregation of individual moods.

Workers' behaviour is multifarious; it may be analyzed through n behavioural variables, $\tilde{X}_1, \tilde{X}_2, \dots, \tilde{X}_n$, depending on r parameters, c_1, c_2, \dots, c_r :

$$(10) \quad \psi = \psi(\tilde{X}_1, \tilde{X}_2, \dots, \tilde{X}_n; c_1, c_2, \dots, c_r) .$$

In general nothing is known about the form of this function. However only some of its topological properties need to be investigated here and much can be said on its qualitative bearings if it is assumed that the family $\underline{\Psi}$ of $\underline{\psi}$ -functions is smooth and generic. Then in the case where $r=2$ and $\underline{\psi}$ is a potential, it is possible to apply a powerful classification theorem of Thom (Thom, 1969, 1972; Mather, 1969; Troatman and Zeeman, 1976) to get the following results :

- for the family $\underline{\Psi}$ of two parameters functions $\underline{\Psi}: \mathbb{R}^n \otimes \mathbb{R}^2 \rightarrow \mathbb{R}$, structural stability is a generic property;

- the set of critical points of $\underline{\Psi}$ is a manifold $\underline{\mathcal{G}} \subset \mathbb{R}^{n+2}$, of dimension 2 ;
- the projection map of the critical points of $\underline{\mathcal{G}}$ onto the parameters space, $\underline{\chi} : \underline{\mathcal{G}} \rightarrow \mathbb{R}^2$, is locally stable under small perturbations ;
- the set of singularities of $\underline{\chi}$ is equivalent to the elementary catastrophe, called cuspcatastrophe, whose universal unfolding is

$$(11) \quad V(\tilde{U}; a, b) = \frac{\tilde{U}^4}{4} - b \frac{\tilde{U}^2}{2} - a \tilde{U}.$$

Three important changes mark the passage from equation (10) to equation (11). First, of the \underline{r} parameters $\underline{c}_1, \underline{c}_2, \dots, \underline{c}_r$, only two, relabelled $\underline{a}, \underline{b}$, have been left by hypothesis. Secondly, a smooth change of variables, $\underline{\tilde{x}}_1 \rightarrow \underline{\tilde{U}}_1$, must have been performed on the original unspecified variables to obtain the new ones $\underline{\tilde{U}}_1, \underline{\tilde{U}}_2, \dots, \underline{\tilde{U}}_n$. Thirdly, of these variables, only one, relabelled $\underline{\tilde{U}}$, appears in equation (11). By Thom theorem any one function $\underline{\Psi}$ is structurally stable on all but one of the \underline{n} variables. The critical points encountered on these variables are all isolated, non-degenerate, critical points. Only one variable may have degenerate critical points. Therefore, to study the qualitative be-

haviour of Ψ under variations of the two parameters, it is sufficient to concentrate attention on the only "bad variable", \tilde{U} and its equilibrium values, U .

Here this is the variable called workers' moods, or workers' action, or political unrest. Such concepts, though defining psycho-sociological variables of different natures, can be used interchangeably if it is assumed these are homeomorphic. Anyhow, each of them would require a different interpretation of equation (11). Here emphasis is given to the variable called "political unrest". Political unrest is behaviour pertaining to a single, collective subject, a class of individuals. It depends on class moods. A frequency distribution of individual moods, as opposed to class moods, can be envisaged like that represented in figure 11. Equation (11) is interpreted as a family of such distributions, the particular form of each of them coming from a particular value of the a and the b parameters.

It is supposed that a process of formation of the "collective will" operates in class behaviour, consisting in choosing the political action for which the support of the highest possible number of workers can be mobilized; such an action must correspond to a mood around which the moods of the greatest number of work

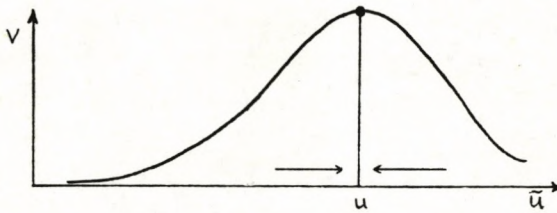


figure 11

ers tend to gather. There is no need to be more precise about this process. Suffice it to say that it turns out in maximizing the frequency distribution of moods. In this way equation (11) can be interpreted as a potential of class moods, given by the moods of all the individuals belonging to the class. Through them a "force" operates tending to form the moods of the class by aggregating individuals around the level of moods pointed out by the arrows in figure 11.

When a and b vary, the form and the critical points of the frequency distribution $V(\tilde{U}; a, b)$ vary. When the frequency distribution is unimodal the criti-

cal points of $V(\tilde{U}; a, b)$ are unique and vary monotonically with \underline{D} . When the frequency distribution is bimodal, up to three critical points can correspond to a vector (a, b) : two maxima and one minimum. In this case, by hypothesis, the critical points vary as a function of \underline{D} broadly in the way described in figure 4. When \underline{W} , too, is allowed to vary smoothly the family of curves drawn in figure 4 originates manifold \underline{G} of figure 5.

Now the dynamic nature of the process of collective will formation may be made more precise. It may be said that class moods or action tend to change in time as a function of a force tending to unify workers' behaviour. Such a force is represented by the gradient of the potential of class moods and dynamically manifests itself through the gradient function :

$$(12) \quad \frac{d\tilde{U}}{dt} = \frac{\partial V(\tilde{U}; a, b)}{\partial \tilde{U}} = \tilde{U}^3 - b\tilde{U} - a .$$

Now maxima and minima of equation (11) can be interpreted, respectively, as attractors and repellers of equation (12) .

The equilibrium solutions of equation (12) are located by the following equation :

$$(13) \quad \frac{\partial V(U; a, b)}{\partial U} = U^3 - bU - a = 0 ,$$

equal to equation 6, the equation of manifold \mathcal{G} .

\underline{U} is an "equilibrium value" of class moods, i.e. a value which, for a given level of \underline{D} and \underline{W} , gathers support from a great number of workers and, therefore, enables the formation of a collective action. Suppose that, at time 1, $\underline{U}_{(1)}$ corresponds to $\underline{D}_{(1)}$ and $\underline{W}_{(1)}$. If at time 2 decentralization and welfare change into $\underline{D}_{(2)}$, and $\underline{W}_{(2)}$, $\underline{U}_{(1)}$ becomes a disequilibrium value of moods. Individuals moods change and class moods will settle at the value $\underline{U}_{(2)}$. Equation (12) accounts for a process of fast dynamics which is stable around the maxima of the frequency distribution $V(\tilde{U}; a, b)$.

The case in which $V(\tilde{U}; a, b)$ is bimodal must be interpreted as one in which workers' moods gather around two opposite states. It could be said that the potential moods of the working class are divided. However class behaviour cannot be. One of the two dominating moods must prevail as a unique determinant of class action and the moods shared by the workers who do not participate in that action will remain as a latent, self-conflicting attitude of the class. Yet the time could come when this attitude will show itself. In this case class behaviour will undergo a catastrophic change from a low to a very high degree of protest or viceversa.

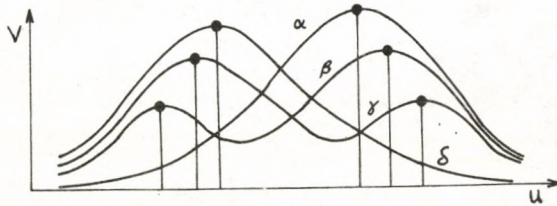


figure 12

Now consider figure 12 and suppose that $V(\tilde{U}; a, b)$ first changes from \underline{a} to \underline{b} , then from \underline{b} to $\underline{\gamma}$ and eventually from $\underline{\gamma}$ to $\underline{\lambda}$. When will the catastrophic change occur? When \underline{b} turns into $\underline{\gamma}$ or when $\underline{\gamma}$ turns into $\underline{\lambda}$? The first case holds true if it is assumed that, for a parameter change, the gradient function must always attain the highest maximum. This assumption is called the "Maxwell rule". The second case holds true if it is assumed that, whenever two maxima exist, the solution of the gradient function will change with the parameters by sticking to the maximum nearest to that attained in the recent past. This assumption is called the "Delay rule". Sociologically the Maxwell

rule implies a sort of majority rule in the process of collective will formation. Delay rule implies the existence of organized groups capable of exerting a moderating influence over class moods, such as to delay (but not to wholly prevent), against the potential will of the majority, drastic changes in collective behaviour. Here the Delay rule has been chosen, but either would do well in the working of the model.

Returning to the main argument, the catastrophic points are degenerate critical points. The twofold degenerate critical points of equation (12) are those in which the derivative of equation (13) is nul :

$$(14) \quad \frac{\partial^2 V(U; a, b,)}{\partial U^2} = 3U^2 - b = 0 .$$

This is the equation of the "fold curve" of \underline{G} , i. e. the curve where the tangent planes of \underline{G} are vertical. The projection of the curve onto the $\underline{U-D}$ plane is the parabolic curve represented in figure 7. Its projection onto the $\underline{a-b}$ plane is the "bifurcation set" of figure 5, in which Delay rule operates. Its equation is obtained by eliminating \underline{U} from equations (13) and (14), and is:

$$(15) \quad \left(\frac{a}{2}\right)^2 = \left(\frac{b}{3}\right)^3 .$$

Maxwell rule operates on the "Maxwell set", which is

$b > 0$.

The fold curve separates \mathcal{G} into two pieces. One is given by $3U^2 < b$ and consists in the single sheet, inside the curve, shown as a shaded surface in figure 5 . This is the set of repellors of equation (12). The other is given by $3U^2 \geq b$ and consists in the blank sheets of \mathcal{G} , as shown in figure 5. This is the set of attractors of equation (12).

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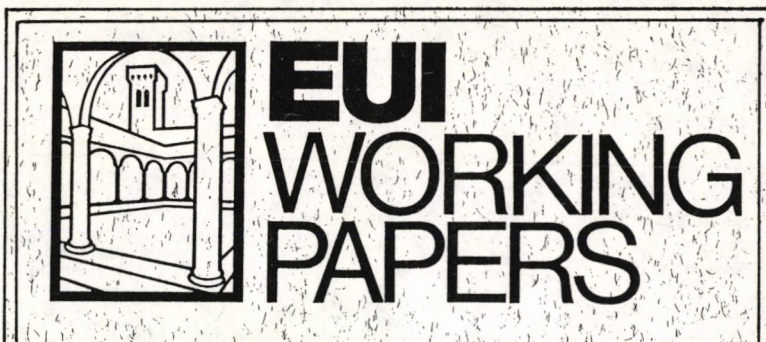
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