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SELF-REGULATION, DECENTRALIZATION AND CONTROL IN ECONOMIC SYSTEMS

There are in economic theory, or - more precisely - in the theory of organization and control of economic systems certain problems being discussed since many-many decades and not yet resolved in a scientific way. Of course, these problems are resolved in practice, on an empirical basis, with more or less efficiency. And one may say, the more complex our economic systems become, the more variable the environment of our economic systems gets, the less efficient become the afore mentioned empirical solutions.

The aim of this paper is to chose two of these old problems and to try to show how an application of systems theoretical concepts, i.e. a reformulation of these questions in the language of systems theory is able to contribute to a scientific formulation of some - in reality all - economic and organizational problems, which is naturally the first step to an efficient solution. This will be done here in a purely verbal way, taking thus only the first step in the direction of an exact solution - and being really at the same time a challenge to mathematicians and systems theorists.

The two problems chosen are: a) centralization - decentralization, b) direct control - indirect control. First it is very important, especially considering the older and more popular discussions about the practical solution of these problems - to get rid

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of a very deeprooted human inclination, i.e. to see things in terms of dichotomies (black or white, good or bad etc.). As always, here too the problem is really not to decide between the merits or faults of centralized or decentralized control, of direct or indirect control. In reality there never existed and cannot exist social systems which are absolutely centralized (or decentralized), and where control is realized only directly, i.e. by command, or only indirectly, i.e. by motivation (to use a shorthand definition). Even in the most authoritative systems there was always room for decentralized decision- making, and even the most ruthless dictator had to mix command with rewards or sanctions.

The real problem consists in both cases in finding the optimal mix, e.g. the optimal degree of decentralization. If we accept this point of view, we have at the same time to recognize that there do not exist unique solutions to these problems, solutions efficient in every case. The scientific approach consists in formulating and - if possible - classifying the relevant conditions or factors and determining on the basis of every given situation, i.e. every given constellation of the relevant conditions and factors the optimal or at least a satisfyingly efficient mixture or degree of centralization and direct/indirect control.

I have chosen these two problems partly because of their importance in modern control theory. The debate about centralization is, as we know, very old, in our countries as old as the centrally planned economy was introduced. And everybody who remembers the history of the reorganizations of our economies since the end of the second World War, or in the Soviet Union since the first five-year plan, must by force see clearly that all these practical solutions were in reality only almost blind experiments, without any scientific basis. The question of direct and indirect control is especially actual in our country since our reform of 1968, which introduced the world-wide unique system of the control of national economy through using the market and its forces in a planned way (that is the principle, let us now and here not speek about the practice). Although these questions have a much wider interest, they being actual and

pressingly unsolved in any kind of complex socio-economic system, be it a capitalist corporation, a multi-national enterprise or even the army etc.

Partly have I chosen these questions because they seem to me to be closely related to the problem of self-regulation and therefore to be solvable through reformulation in the language of systems theory, using especially this one systems theoretical concept.

First, let us define the concepts used.

By centralization I mean the way decision making power is distributed in a hierarchical decision system. In a hundred percent centralized system there exists one and only one decision making center. In a hundred percent decentralized system there does not exist any decisional hierarchy, all the decision centers are independent of one another. The degree of decentralization means the distribution of decision making between the several levels of the decisional hierarchy, and it includes the number of levels as well as the width of the levels and the degree of decisional freedom at the several levels, i.e. what kind of decisions are delegated from level to level, or in other words: what is the content of the decisions at the several levels. One hears often a rule of thumb, namely that we should delegate to each level those decision which are informationally supported at that and no other level. I do not think that there exists such a strong correlation between informational support and decisional power. This rule was behind those illusions one could meet at the heroic time of computerization, when many people (e.g. the late Professor Nemchinov) thought, a well organized net of data banks would enable the central authorities to introduce the perfect central planning system. We know now already that this is not true - not even the most perfectly functioning data bank system would enable us to plan a complex system from one and only one decision center.

By direct control I understand a control system giving only commands (informations of a pragmatic content) to the subsystems and elements, which have to obey these commands literally. By indirect control we mean a system where the decisional centers or points are not giving any commands but only motiva-

tional informations to the subsystems and elements controlled, and these elements behave according to the intentions of the controlling system because their interests (objective functions) can be realized only by avoiding the sanctions and getting the rewards coded in the afore mentioned motivational informations. It is well known that modern pedagogy e.g. inclines to applying solely indirect control in education. Obviously, a hundred percent centralized system applies only direct control, while a hundred percent decentralized systems can apply only indirect control. In reality, as I mentioned already, in complex socio-economic systems we see always some kind of mix between these two kinds of control and decision making, and our purpose is to find a scientific way for determining the optimal mix.

Socio-economic systems are man-man or man-machine systems. I.e. they are systems whose elements are partly or wholly themselves highly organized, complex systems, with their own purposes, with their own objective function, although this is here only a metaphore, because the objective function of people may not be expressed in a quantitative form. Neither may be, by the way, the objective function of complex socio-economic systems wholly formalized. And this is why these systems have to be always a mix. People take decisions in any case, according to their own interests. If the elements of a machine do not obey the commands of the decision center, we say that they are out of order. If the elements of man, as a system, to not obey the commands of the decision center (in those cases where they do not have to obey inborn reflexes) we say that they are ill. But if the elements of an economic system do not obey commands, if workers are e.g. striking, the system may be ill, but its elements do only exert their sovereign rights. Therefore in a socio-economic system the human elements have to receive some degree of decision making power, and there has be some degree of indirect control, motivating them to take their decisions in accordance with the goals of the whole system. The question remains: what degree?

One of the important properties of highly organized, complex socio-economic systems is their capacity of self-regulation. By self-regulation we mean the ability of the system to return to

its equilibrium after any kind of inner or outer disturbance, by itself, without any intervention from outside. Without occupying ourselves here with the very complex mechanism of self-regulation, we may mention only, that this is achieved by the interaction of the several control loops built into the system, an interaction leading to multi-stability and ultra-stability of the system. In man this property of self-regulation is manifesting itself by our ability to return to our equilibrium (health) without medical interference, supposing we are leading a so-called healthy life. A breakdown of self-regulation leads to the destruction of the system, man e.g. dies.

Socio-economic systems do not have such a well-defined equilibrium state as biological systems have. Socio-economic systems are developing, mostly growing systems and they, after leaving a given equilibrium state do not return, with the help of their self-regulating ability, to the same state, but they are developing in the direction of another - higher level, or otherwise defined - equilibrium state. That is why we talk in the case of economic systems of a moving equilibrium. Again we do not here go into the details of this mechanism, for our purposes it is enough to know and define the self-regulating property of complex socio-economic systems.

We are here more interested in the factors determining and influencing this property. If we understand them well, we may find a way from self-regulation to the problems of decentralization and direct/indirect control, at least at a conceptual and question-asking level.

The most important of the factors making a system self-regulating is its ability to learn and to alter its behavior on the basis of the conclusions drawn from the new information derived from learning. In relation to self-regulation learning means the following: Informations about all the changes influencing the system's striving to keep its equilibrium or endangering the maintenance of the equilibrium state are partly flowing into the system's memory, partly actively sought by the system. In the memory this information is stored and when the indicators of endagered equilibrium state surpass a certain threshold, they flow into some organ of the system destined to make a comparison bet-

ween the goals of the system (which may be the maintenance of the given equilibrium state, or the definition of some new equilibrium) and the disturbing influences (factors), i.e. the values of the relevant indicators. After deciding in this organ between the old and some new equilibrium state, the controlling subsystem of the socio-economic system works out plans and strategies destined to alter the behavior of the system's subsystems and/or elements concerned, i.e. those whose behaviour has to be changed to attain the old or the new equilibrium state. This mechanism of learning and alterning of behaviour exists in all known socio-economic systems, only in our real systems they are mostly not very well organized, not functioning on a consoious level but acting rather unconsciously, spontaneously.

Nevertheless, even this unconscious functioning of the self--regulating mechanism protects our economic systems from destruction or self-destruction. Only its efficiency could be much higher.

A very important factor taking part in the self-regulating process are the buffers built into the system, the so-called reserves. These buffers are lying between the several control loops of the system and their action contributes to the multi-and ultra--stability of the system. The buffers act on the basis of the well-known localization principle. The localization principle means that if the functioning of a given element of the system is in equilibrium, so that its inputs and outputs do not collide against the constraints of its action in a given time-interval, then the changes in its functioning do not influence the functioning of the other parts of the system in that time-interval. This principle is of great importance, because it is one of the factors guaranteeing the stability of the system in that way that minor disturbances are "localized", i.e. locally counterbalanced. Only major disturbances pushing the inputs and/or outputs of the given element or subsystem beyond the given constraints, in the given time-interval, are disturbing the functioning of the system as a whole - if there are no buffers. The role of the buffers consists in counterbalancing those disturbances, or "localizing" them, which go outside the given subsystem and would otherwise disturb the functioning of the whole

system. Now, learning too may be interpreted as a kind of buffer in this sence, because through learning the system builds buffers containing informations, i.e. the local memories of the system are nothing else than a kind of buffer or reserve, enabling it to counterbalance - through activating these information buffers and altering in that way the behaviour of some of its subsystems - major disturbances.

Again, a conscious organization of local memories (which could nevertheless be well defined parts of the data bank of the whole system) would contribute to enhance the learning capacity of the system, its better adaptation to disturbances in the environment and its more efficient selfregulation.

After this attempt to define the most important concepts we are here working with, and to give an outline of the mechanism of self-regulation, let us sum up what we know in relation to our basic question.

1. Any socio-economic system includes necessarily a decision hierarchy, a decision making and controlling subsystem with a distributed decision making and controlling function (i.e. this function appears distributed through the afore mentioned hierarchy). The question is not: centralize or decentralize, but: how to organize this decision making and controlling subsystem, how to locate in our system the decision centers, naturally including the information flows necessary for the preparation of rational decisions.

2. This decision making and controlling subsystem being hierarchically built, i.e. in that way that the top management controls controllers of a lower level, those control again controllers of a lower level etc. through to the last operative levels, the question is the following: how to locate in this system the controlling powers, or formulated otherwise: which should be those parameters in every control loop, through which the higher level intervenes into the behaviour of the lower level. Otherwise: which should be the content of the informations flowing between the levels from above to below, which content changes naturally from level to level.

3. Because the controlling subsystems to the lower levels may be human or computers, depending on the degree of automatization

of the controlled activity, there arises the question of the character of the parameteres mentioned above, i.e. should they be commands, or a mix of commands and motivations (if the controllers of the lower level are human), and in this later case, how should the proportions be in this mix and what should be the content of the motivational informations.

If the controlled subsystem (which may itself be the controlling system of a lower level subsystem) contains activities which cannot be algorithmically formulated, or only partly so, then we need a human operator. This human operator has, as we know, his own objective function, and to be controllable, the controller has to give the motivational parameteres such a content that the goal of the whole system should be in the objective function of this operator a behavioral criterium with enough weight to adapt his behaviour to the goal of the whole system. I.e. the motivational information has the function to modify the objective function of the human operator in the interest of the whole system whose part he is. This motivational information is in reality always present, even if it is not made explicit.

The problems summed up in the three points above are closely intertwined. We cannot give a general solution to them, because such a solution does not exist. There does not even exist an adaquate theory for these questions, but systems theory and especially the theory of self-regulation may give a general conceptual framework with whose help we may arrive at a formal theory, if mathematicians take it upon themselves to work in this direction. Let us look at this direction.

1. We have to acknowledge that all socio-economic systems consist of interrelated control loops.

2. If any of these control loops are not wholly automathized, i.e. if there are human operators in it, than it is in itself a learning and self-regulating system (amongst others).

3. The relations between the self-regulating control loops have to be organized taking into consideration certain principles. These are (putatively):

a. Before putting the control loop into action (on any level) we have to formulate the goal it has to achieve by its functioning, the output we want from it, its way of functio-

ning, i.e. its transformation rules, the criteria by which its output is valued, the information it has to feed back.

b. The next step is the planning and organization of its ability to counterbalance disturbances. That means: projection of the character of the probable disturbances, such a determination of its behaviour which provides it with autonomous counterdisturbance reactions, such a determination of its inputs (resources) which can be in the case of disturbances elastically changed.

c. We have to consider that the control loop begins, after having been put to action in the above sense, its own life, i.e. it becomes self-regulating. The higher control level has regularly to watch the dynamics of this self-regulation, but already in organizing the control loop according to points a. and b. it has to be taken into consideration, what degree of self-regulation and the self-regulation of which parameteres (characteristics) we want to allow this control loop.

d. Taking into consideration the autonomous self-regulating and counterdisturbance capacities of the control loop, we have to determine the content, periodicity and intensity of the control signs, so that controlling interference should be neither too intense nor too weak, because both are able to generate new disturbances in the activity of the control loop. In our practice too intense intervention is the more frequent fault of economic control, putting constraints on the autonomy of the controlled systems. Here steps in the question of the mix of direct and indirect controls again, because in a given situation a command is able to hinder the optimal functioning of the controlled subsystem, although a motivational information could have the opposite effect. If on the other side disturbances are so intense that the autonomous counterbalancing capacity of the system is unable to cope with them, commands will be desirable.

In general one may say, the more human elements are active in a given system, i.e. the less the system is automathized, the more "autonomy" should be given to the several subsystems or control loops - provided we find a sufficient number of adequately trained and motivated "human elements".

Vilmos Neméný

SAMOREGULACJA, DECENTRALIZACJA I STEROWANIE W SYSTEMACH EKONOMICZNYCH

W teorii ekonomii, lub dokładniej w teorii organizacji i kierowania systemami ekonomicznymi, występują określone problemy, które do tej pory nie zostały precyzyjnie naukowo opisane. Są one jedynie mniej lub bardziej efektywnie rozwiązywane w praktyce. Do problemów tych, zdaniem autora, należą zagadnienia centralizacji i decentralizacji oraz zarządzania bezpośredniego i pośredniego, jako rozwiązań alternatywnych.

Prezentowana praca wskazuje możliwości, jakie daje zastosowanie koncepcji systemowych oraz języka teorii systemów w naukowym opisie wyżej wymienionych zagadnień. Autor poświęca wiele uwagi strukturze systemów społeczno-ekonomicznych oraz ich funkcjonowaniu.