Systemic Influences on the Economic Performance of the Ukraine.

Abstract
This paper deals with a systemic attempt to understand the economic transition of the Ukraine which represents a typical former Soviet Republic which gained independence in 1990. Our approach uses a combination of various Cybernetic, System Dynamics and Operational Research approaches. This paper concentrates on the Qualitative System Dynamics approach taken. We give a brief overview of the cybernetic approach explaining our view of production units and production chains. We then explain a major causal diagram that is embedded in the recursive structure of the cybernetic approach. We also explain the appearance of barter by using a causal approach.. The paper illustrates how System Dynamics and can work together

1. A Cybernetic Overview

Our novel study of the economic problems of the Ukraine has been via a systemic approach with an emphasis on System Dynamics and Cybernetics. It is our contention that many of the problems in the transitional period are inbuilt systemic ones resulting from cybernetic deficiencies. The details of this approach are a topic of another paper. This paper concentrates on System Dynamics Modelling embedded in a recursive structure taken from Cybernetics.

The cybernetic approach to complexity uses levels of recursion. These are always subjective as they are produced from the mental models of the observer thus reinforcing the concepts of second order cybernetics " the role of the observer is not independent of the process being modelled". We have proposed two structures for the Ukraine. Figure 1 represents the Ukraine before transition and figure 2 some time after transition started. We do not claim knowledge of the mechanisms of this transformation, or the ontological status of the models. Our only claim is that the models proposed fit the pattern of the perceived experience.

It can be seen that we have introduced four levels of recursion. The various entities at each level can be unfolded into a lower level e.g. in figure 1, material production at level one can be expanded at the second level into Production Chains which themselves can be unfolded into Production units at level three.

At each level of recursion, a Viable System Model (VSM) has been formulated. A VSM consist of five subsystems: the System Ones are the producers of the system at the next lower level of recursion and each VSM has a Resource Bargainer called System Three. System Two is an anti-oscillatory device to help the System Ones in this resource bargaining and System Four has the responsibility of anticipating the future. The final system, System Five, represents the Ethos of the whole. Beer has carefully charted the requisite necessary channels between these systems and the Viable System approach consists of mapping the system to be modelled onto the VSM and analysing the differences (Beer, 1972, 1979, 1985)

2 .The Recursive structure of the model.

An economic system should be considered in this paper as a living system. For example, Krugman (1996), among others, considers an economy as a self-organising entity consisting of a set of uncontrolled, but self-organising processes. In this paper self-organisation has been applied to explain changes within the systemic environment. At the same time, it is postulated that autonomous economic agents, which are communicating with each other, create systems of a higher order. Such couplings have a recursive structure. Beer's Viable System Model is then used as a basis to hypothesise an economic system as a recursive, autonomous, adaptive, self-referential living system, which survives within a self-organizing environment. The relevance of this hypothesis to the Ukraine is now briefly explained.

It begins with the recursive structure of the model shown in Figure 1. To show the unfolding of complexity, the viable systems, nested in the system "Ukraine as a Nation", are identified and their functions are described. It is important to note that the structure shown is at the time of the Ukrainian independence, which inherited all the traits of the command system of the former Soviet Union. Following Beer's idea, the System "Nation" embeds a set of interrelated systems, which produce the Nation and constitute the economic, social, cultural and military, identity of the Nation. Our work explores some mechanisms of the transition from the command to the market-oriented mode of economic governance. Therefore, the system of concern is the one, which is in charge of economic identity of the nation.

The system – in – focus is the "System of Material Production[1]". It can be viewed as a large corporation where a central planner (the management of that system) allocates resources between its "subsidiaries". The corporation owns a large stock of natural resources, has no outside shareholders (so that all "profits" can be kept for investments) and hires labour. Moreover, as a monopolist in the labour sector, the corporation, can minimize expenditure on labour. Transactions between enterprises are merely transfer prices between "divisions". The exceptions are purchase of labour and engagement in foreign trade. As Ickes (1999) argued, the objectives for this corporation is the satisfaction of government consumption (primarily defence), subject to the constraint that labour is supplied in proper quantities. In order to obtain sufficient labour the corporation must produce consumer goods, including agricultural output, to induce this supply. Such a corporation is thus seen as a means of producing items for government consumption. Primarily, it was military production, but obviously it took other forms, such as education, health, etc. This point has also been made by Wiles (1977):

> *The single enterprise is identified with the state. Its Board of Directors is the Cabinet (or may be Politbureau). Its treasurer is the Minister of Finance. The profits of its branches, rather misleadingly, called enterprises, go automatically to this Minister; they are decentrally retained by grace and*

[1] We used the term "material production" widely accepted in a command economy to stress that elements of the System of Material production" is merely or primarily oriented to produce products and services, without financial considerations. The process of production is not always coincided with profitability or value adding. Often it was not even clear whether a producer value-adder or not, due to distorted calculation techniques. And may be even due to the absence of such necessity to make these calculations, because in a command economy quantitative indices (such as production growth, percentage fulfillment of a plan, etc), instead of financial results, were in use.

favour only…There is not even any distinction between managers and civil servants. There is only one career structure with total transferability of pension rights, seniority, etc.

Summarising, the system of "Material Production" is a system, which is concerned with any kind of production. "Any kind of production" encompasses any activity, where goods and services are produced. The purpose of the system "Material Production" is to organise and use human and natural resources in order to satisfy the specific needs of the system "Nation" (such as education, health, defence)

One must be aware of myriad possible representations of the system "Material production". Any modelling construct depends upon its tasks. For example, Beer's model of Chilean economic system had eleven levels of recursion between the nation and the production level within a business. I may assume that Beer needed such a detailed elaboration, intending to create novel mechanisms capable of running the country. For our diagnostic purposes we intentionally avoided differentiation by industrial specialisation. This permitted us to get rid of several levels of recursion, and allowed us to concentrate on those instances of operational coupling, where, as we believe, the major sources of instability might be observed. We focused on the fact that elemental units (let us call them "production units" so far) combine together into "production chains" to accomplish a conceived task.

To explain the validity of such a view, let us refer to Hofstadter's (1979) explanation of the self-organisation of an ant colony. When ants need to accomplish a task, they form small "teams". Small groups of ants are constantly forming and dissipating. The only reasons for the team's existence are that they have a task to be done and there is a vital reason for such a team. For instance, in performing a food-gathering task, the number of ants who will respond to a task about food discovery, would be proportional to the size of the food sample. If the sample is inconsequential, it won't attract enough ants to surpass a required threshold needed to complete the task, e.g. too little food will be ignored. Making the analogy, we can spot the same behaviour of "production units" in the socio-economic system, which engage together to produce more complex products. For example a car manufacture organises an alliance of different producers to complete the task of car manufacturing. Such allies (We call them "Production chains") cannot be considered, at least for some time, as random consumers or suppliers. Behaviour of "production chains" is organised and scheduled in a predetermined manner, which requires successful task accomplishment.

Ant teams are one of the levels of structure, which exists between ant level and colony level. Hofstadter called them "signals", pointing to their specific nature, which comes from their function. The effect of "signals" is to ensure that ants of various specialisations are at the appropriate places within the colony. The "signal" arises when the threshold needed for survival has been exceeded, and the task has been accomplished. It then migrates through the colony. Eventually it dissipates, when the purpose of its existence has ceased. This explanation is very similar to Prigogine's (1996) description of dissipative structures:

"Thermodynamics leads us to the formulation of two conditions for the occurrence of dissipative structures in chemistry:

(1) far-from equilibrium situations defined by a critical distance[2];

[2] "Critical distance" is the distance from thermodynamic equilibrium for a given chemical reaction, when reaction becomes unstable, i.e. a set of new phenomena arises.

(2) catalytic steps, such as the production of the intermediate compound Y from compound X together with the production of X from Y.

It is interesting to note that these conditions are satisfied in all living systems: Nucleotides code for proteins, which in turn code for nucleotides."

These two examples give us important inferences about the nature of appearance and existence of "Production chains". A set of critical circumstances is needed which define a purpose for an emergent organisation. This then instigates the formation of a critical mass of entities (production units) capable of carrying out the purpose. There is then a logical restructuring of the recurrent processes fulfilled by "production units" at the meta level. This metasystemic organisation of "production units" we call a "Production chain". The stability of "Production chains" depends on the circumstances which gave rise to its formation. "A Production chain" will exist as long as the critical mass of "Production units" with concerted purposes exists in an accessible surrounding. It is worth noting that it is the critical mass of "Production Units" that is important, and not the "Production Units" themselves.

For a description of the system "Material Production" at the time of Ukrainian independence, one should be aware of the fundamental traits of the command system - asset specificity[3] of the production pattern. The tendency of the "central planner" to optimise resource allocation led to massive attempts to introduce economies of scale, which led to a situation known as "small-numbers exchange"[4]. The absence of competition stimulated the establishment of relatively stable technological chains without deep horizontal diversification. We identify these vertically integrated groupings[5] (or Production Chains) as Systems One of the system "Material production"[6]. Consequently, the system "Production chains" encompass Production Units (enterprises). This chosen recursive scheme has three levels of recursion. As such, it may lose some of the diagnosing power of the VSM , but such generalisation allows one to see the forest as opposed individual tree.

In our work, we claim that the Meta-systemic "governance" (meaning the self-organisation of the systems "Nation" and "Material production" down to the corporate level) is responsible for and creates mechanisms of the sustainable existence of the whole system. We also show that if these mechanisms are not created in a timely manner, then the system seeks to adapt itself to unregulated disturbances in the ad hoc regime. Therefore, the main concern of the diagnosis is on meta-systemic cohesion. It is primarily focused at the levels of "Material production" and doesn't go beyond the elemental structure – "production unit". We also do not identify exact production chains, substituting them by abstract representatives. This simplification doesn't affect the main purpose of intended diagnosis and is legitimate as long as we are concerned with the problems of governance within the system "Material production".

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[3] An asset is specific to a given exchange relation (or *transaction*) to the extent that it cannot be redeployed for use in another context without appreciable loss in productive value.

[4] Williamson call the situation as a small-numbers exchange, when there are few parties available to fill one side of an exchange, whether supplier or buyer.

[5] In economic theory vertical integration means merger of technologically related operations under the one controlling center. In the command economy vertical integration is the most dominated phenomenon.

[6] In comparison a market economy relies, essentially, on parallel links. In competitive markets such reliance produces defensive mechanisms from the market failures.

3 Key Concepts

An explanation is now given of two key concepts that are used in the causal modelling.

3.1 The concept of an Institution

The concept of an institution has to be interpreted very broadly in this context. It includes, for instance, the prevailing legal order in the system concerned, its moral norms, its property rights, the distribution of power, etc. Special attention must be paid to the distinction between institutions, which emerged as a result of metasystemic decisions and adjustments, in the course of an evolutionary process, and other institutions, which are ad hoc self-repairs of an autopoietic system. e.g. the necessity to undergo unreported activities required the creation of additional institutional mechanisms. (shown as the "relaxation loop" in figure 4.).

3.2 The process of norm creation.

Path dependence[7] arises in systems whose dynamics are dominated by positive feedback processes. This dynamics can be described by a non-linear Polya process, after its inventor, the mathematician George Polya (Sterman, 2000).

As an example, let us consider the formation of a bureaucratic system and two norms – honesty and corruption, which are equally likely. Two of the factors affecting its future state will be the salary of officials and strength of law. In this example, it is assumed that the only factor affecting the acceptance of bribes is a financial one. Thus morality and the pursuit of power are excluded. Consider the causal-loop diagram, shown in figure three.

The figure describes the dynamics of evolution of corruption. Suppose a new official has just began to work in the bureaucratic system and it is not yet known if he is corrupt or honest. The probability that he will accept bribes depends on the environment. The Polya system has two feedback loops, one positive and one negative loop for each group of officials. The greater the number of bribe-takers, the greater the probability to become a briber (network effect- positive loop). At the same time the greater the total number of officials, the less impact a bribe-taker will have on the dynamics of the whole system (negative loop).

This example reveals the spontaneity of norm creation, which is a substitute for the scarcity and underdevelopment of the institutional market infrastructure and which is responsible for the "uncontrolled" systemic self-adjustments to external shocks

[7] Path dependence - a pattern of behavior in which small, random events early in the history of a system determine the ultimate end state, even when all end states are equally likely at the beginning. (Sterman, 2000).

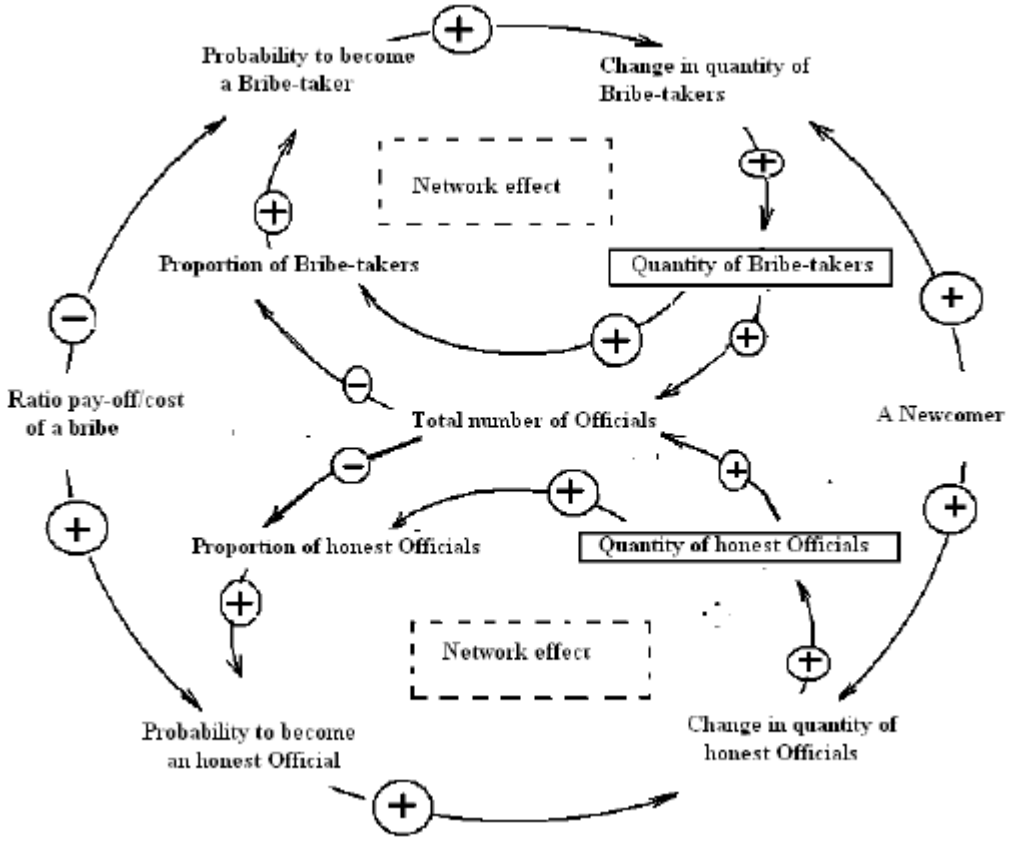

Figure 3. Path Dependency

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3.2.1. The Barter Trap

As another example, let us consider the appearance of what we term “the barter trap”. The principle of path dependence is the same as in the previous example. This is represented by the positive feed back loop shown in the Figure 4 connecting institutional changes, the capability to control economic processes, the economic anomaly known as “hyperinflation”, barter transactions, and change in output. The Ukrainian government in 1992-1993 faced the problem of support of a number of important state owned economic sectors (such as the agricultural sector or heavy industry). External disturbances complicated the perspectives of the financial survival of these sectors. Urgent measures, presumably for the improvement of economic performance, were substituted by immense subsidies to these sectors which were experiencing losses. This caused hyperinflation. (Kravchuk, 1996) Hyperinflation in turn even more depreciated the assets of enterprises, which then called for more financial support and state grants to replenish operating capitals. Barter became a new mode of behaviour and a new strategy to evade inflation tax. It was fixed as a norm, when the vast majority of economic agents chose this strategy. Alternative means of payments (like bills of exchange) were developed and widely used instead of money. That eventually led to the development of the stable organisational pattern called “Virtual Economy Trap”, which is a topic of another paper.

4. A Qualitative System Dynamics representation of the transformation processes.

The causal loop diagram (Figure 4) shows how, during the transformation process, a diversion of resources from the maintenance of primary activities occurs in order to facilitate creation of the systemic elements needed to maintain its homeostatic status. It is now discussed in detail.

4.1. The influence of "Pool of funding" on systemic adjustments.

Equipped with the idea of norm creation, we can now illustrate the dynamics of resource reallocation connected with the processes of institutional evolution. The systemic resources are represented as a stock "Pool of funding" which combines all the resources available to the system "Nation" and to its embedded subsidiaries: material and financial assets, human resources and intangible assets such as talent, reputation, etc. Essentially, the pool of funding is the quantity of resources available in an economy to support future production. "In the simplest of terms: a lone man on an island is able to pick 25 apples an hour. With the aid of a picking tool, he is able to raise his output to 50 apples an hour. Making the tool, however, takes time. During the time he is busy making the tool, the man will not be able to pick any apples. In order to have the tool, therefore, he must first have enough apples to sustain himself while he is busy making it. His pool of funding is his means of sustenance for this period-the quantity of apples he has saved for this purpose". (Shostack, 1999) In our case the size of this pool determines whether or not institutional norm can be introduced. If it requires a certain amount of resources (human, capital, etc), for instance, for the society to introduce new institutional norm, but it can dispose only a half of this amount, then the norm won't be introduced. In the best case it won't be introduced at all, at worst, resources will be spent without any positive result.

All the System Ones of the System "Nation", which fulfil their primary activities, reproduce resources and replenish the stock "Pool of funding". In figure 4, the level of the stock "Pool of funding" affects the volumes of the inflow rate making a positive loop of the reproduction processes. It is also assumed that it is drained after the Resource Bargains have been distributed to all System Ones. For convenience these recurrent outflows and inflows, associated with the recurrent self-reproduction and Resource bargaining have been averaged out and focused on a net surplus, which changes the current state of the stock. The conventional measure of the volume of reproduction process in the system "Material Production" is GDP[8].

The causal loop diagram differentiates between two types of expenditures inherent to systemic transformations of transition economies. They also affect the stock "Pool of funding".

- The first type of costs is "sunk costs" and is connected with the diversion of investment resources from traditional economic spheres, in order to create new economic and political institutions.

[8] We should agree with S. Beer, who pointed on the flaws of such estimations. As long as they don't describe completely the state and nature of ongoing processes. For example, GDP doesn't include unreported activity of the System of "Material Production". In contrary it includes a variety of types of income, which is not concerned with reproduction, e.g. profits from stock holding.

- The second type of expenditures is more indirect, and associated with the decreasing rate of reproduction of the systemic resources, i.e. when the resources are used less efficiently, due to overall systemic inefficiency.

It was observed that if the investments of the first type are insufficient, then "losses" of the second type increase considerably.

4.2 Institutional Transformation Costs

At the level of "Nation", the metasystem has to invest in new institutional mechanisms, which will facilitate the process of material production at the lower levels of recursion. This type of costs Polterovich, (1999) called "institutional transformation costs". They can be considered as the "fixed" investments produced by the system to arrange additional services, which facilitate system's stability, controllability, and the homeostasis between core elements. Such expenditures are usually considered as sunk costs. "Fixed" investments improve the quality of the subsystem's operations, using the resources of the stock "Pool of funding" (in the figure 4 this is shown as the outflow "Transformation costs"). For example, during transition process the shift in enterprise ideology from "Production Unit" (defined as a participator in material production and an executor of given plans) to "Economic Agent" (defined as an autonomous and independent decision maker) demanded considerable resources to be invested, in order to complete such a transformation. Such investments had to be made at all levels of recursion.

However, as with any investments, there is a pay-off period. The return on these investments is gradual and results in increasing the overall efficiency of self-reproduction process and consequently raises the inflow rate to the "Pool of funding". The consequent reconstruction of the system's structure and adaptation of behavioural patterns takes some time and is dependent on the system's capacity ("Pool of funding") to facilitate such alterations. As this capacity decreases, the gap between the real and desired state of the system increases and therefore bigger delays occur. As a consequence, until the facilitating sub-systems reach a desirable condition, disorganisation in their interactions is very likely. The effect of this disorganisation is largely predetermined by the initial conditions, which describe systemic properties and define the scope of emergent problems after the shock is imposed on the system.

3.5. Withdrawal

Disorganization can be overcome if the "quality" of control over the primary activities is sufficient to provide the necessary self-adaptive changes. An appropriate measure of systemic self-regulatory functions is the level of transaction costs. Therefore initially, the effect of disorganization can be observed in the increase of transaction costs, resulting from the increase of uncertainty in the environment. An increase in transaction costs signals that the system is regulating primary activities less efficiently than in previous periods. It points to the necessity of institutional changes and defines a gap of required institutional changes. The gap between the actual and desired states of institutional settings, defines the desired pace of changes and volume of resources required to close the gap. (In figure 4. the positive feedback loop "Withdrawal of systemic resources" is depicted. It affects the rate of transformation costs).

In the causal diagram, institutional changes are shown as an integral function of the current speed of institutional changes. The later is in turn dependent on the available resources ("Pool of funding") and the gap between the actual and desired state of institutional settings. In this case, "Pool of funding" is a constraint, which limits opportunities to provide thorough reforms. The speed of transformations can also be dependent on the exogenous variables "initial conditions" ("hidden burdens") of the system's properties. The derivation of resources from the economic activity associated with building new institutions in Ukraine was, for example, more excessive due to the disunity within society, caused by a clash between the executive and legislative branches of power. This considerably affected the speed of the reforms and subsequently compelled the System to create ad-hoc anti-oscillatory devices. Later it was interpreted as one of the unanticipated outcomes of reforms.

These constraints stimulated the delay of institutional transformations and as a consequence boosted the growth of transaction costs. Increased transaction costs affected the fall in output and decreased the overall efficiency of the system "Material production". This type of costs dominated during the first stage of the transformation in Ukraine and is still there although its effect is diminishing by the ability of economic agents to adopt new institutional settings.

5. Conclusion.

This paper shows how Cybernetics and System Dynamics can work together. When modelling very complex situations, a System Dynamics model tends to become very large with hundreds (maybe thousands) of variables. This makes it very difficult to test or validate. By using the recursive structure of a Viable Systems Model, one can site or position the SD analysis in a more restricted environment thus enabling more precise models to be built and tested. In the authors opinion, this is a useful way of combining the two techniques. We have demonstrated our approach with an example taken form our work on the transitional economy of Ukraine.

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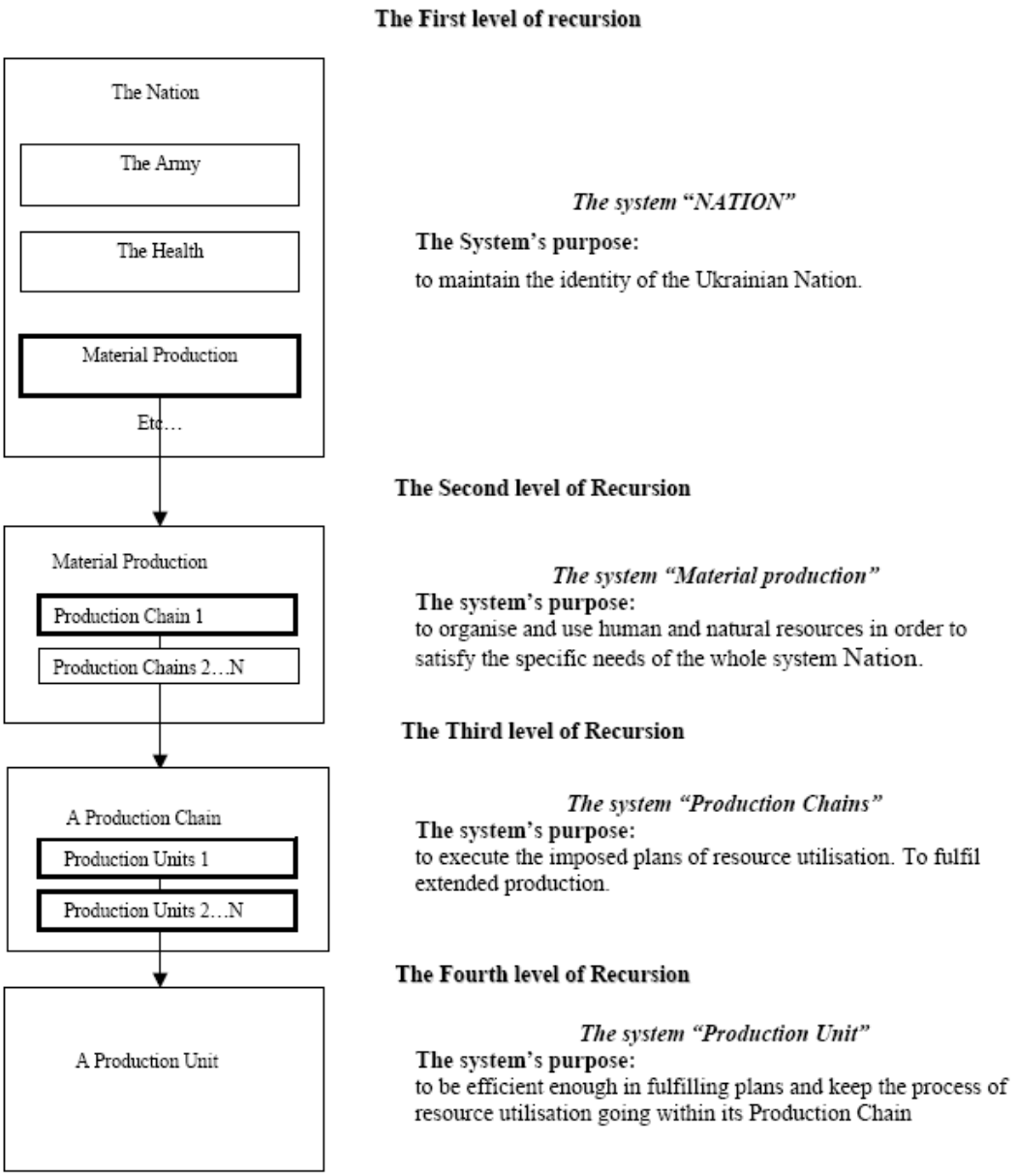

Figure One. The Recursive Structure of the system "Nation" before the transition.

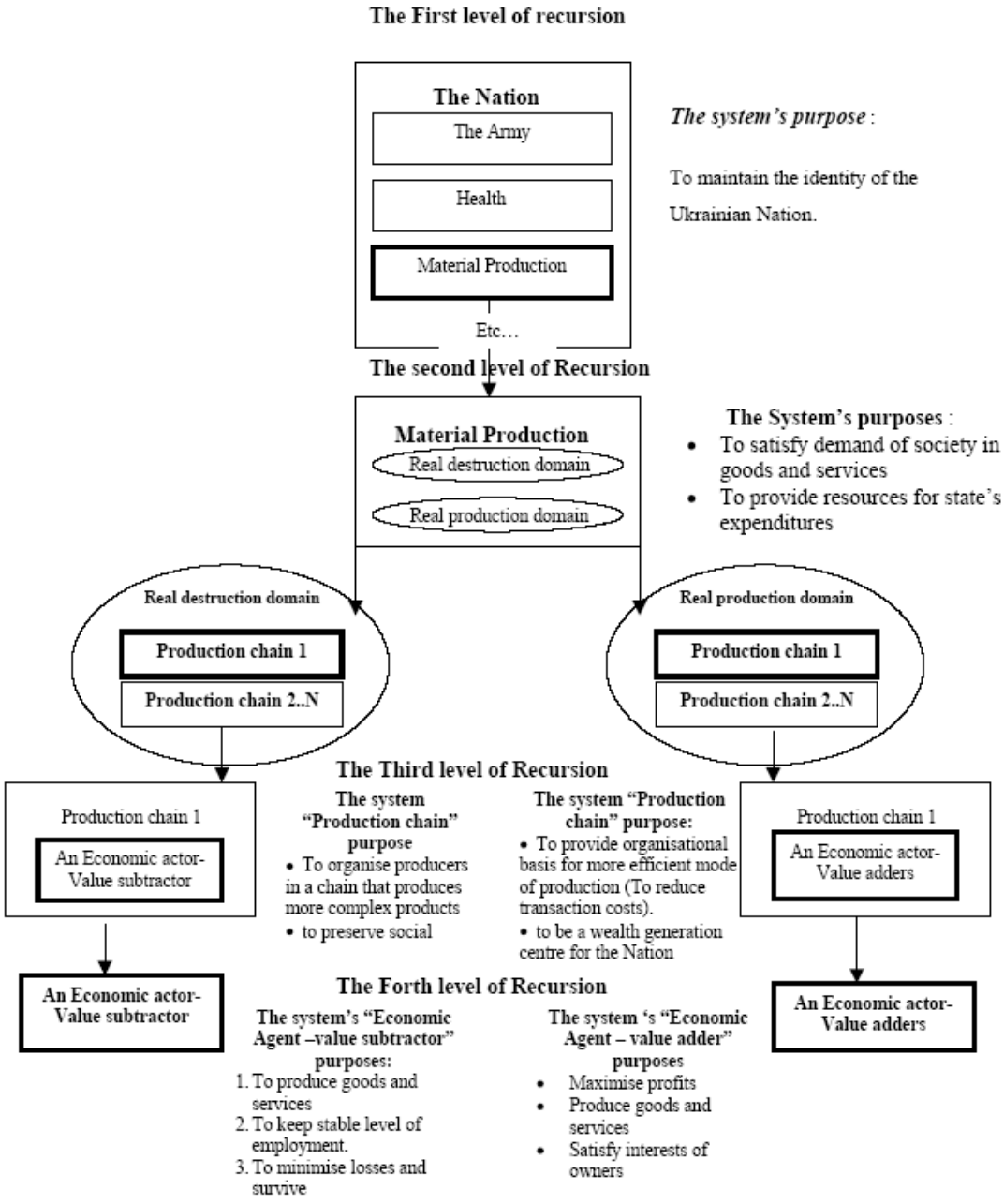

Figure Two. The Recursive Structure of the system "Nation" after the transition.

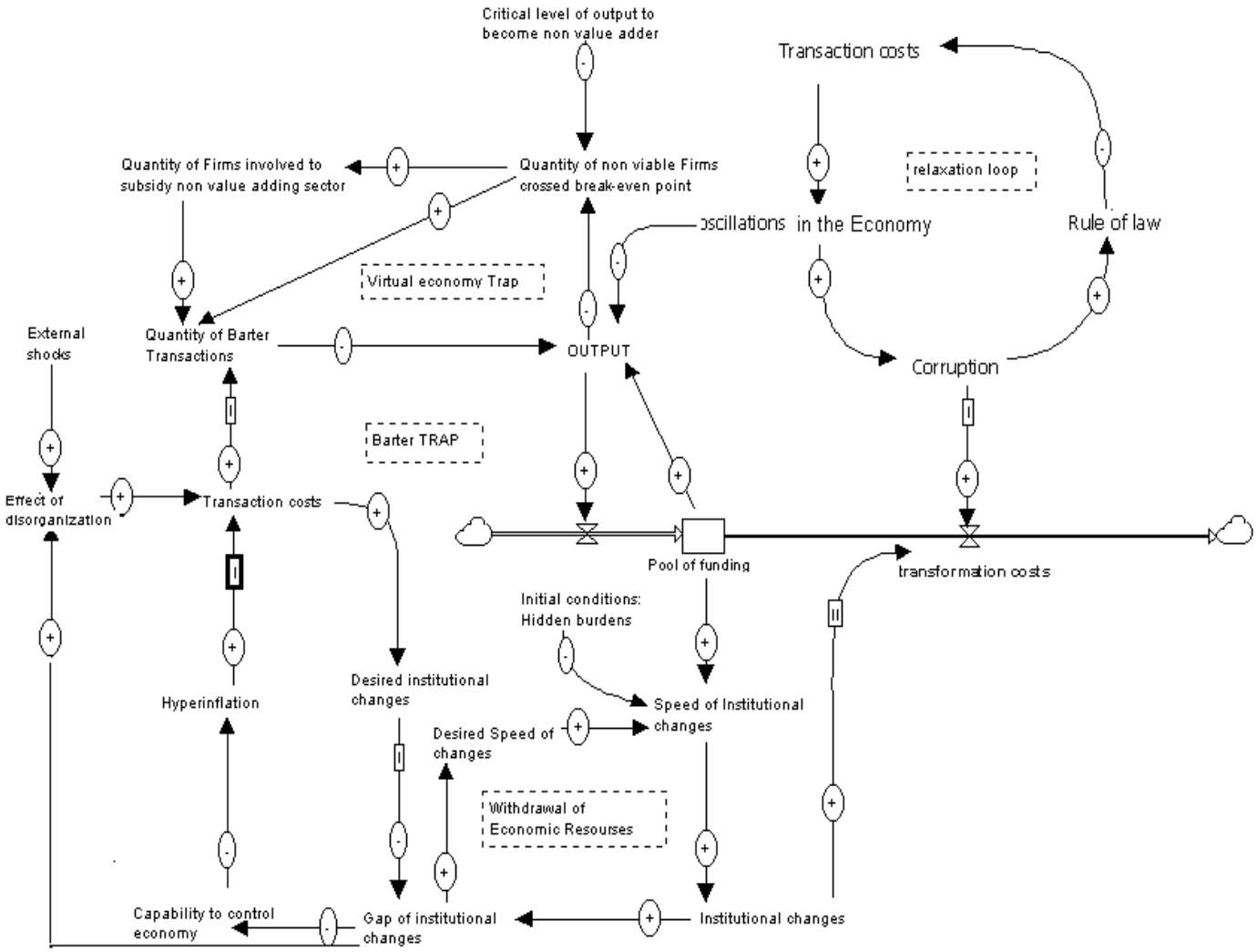

Figure 4. Causal-loop diagram: influence of systemic adjustments on economic performance.

Back to the Top