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FUNDAMENTAL ADVANTAGES OF SYSTEM-STRUCTURAL METHODICAL INSTRUMENTS FOR ELABORATING STRATEGIES FOR DEVELOPMENT

Knowing the structures is a base of the normative system theory. Lately, the methods of creating and maintaining optimal system structures play a founding role in this sense [*]

The paper presents twelve fundamental advantages of the system-structural approach – as an alternative to the applied structure-indifferent approach (the latter is based on the inadequate premise "under equal other conditions") when working out development strategies. The suggested approach is brought to acting methodical instruments (algorithm) in the form of iterative procedure. It is applicable only for the open production systems with compensation retroactions. The multiplicative effects and the action of the automatic stabilizers are realized with maintaining the dynamically changing balancing between desired results and resources needed.

JEL: C82; O21

The financial crisis and the economic crisis following it, with their unforeseeable outcome, call for re-evaluation of many significant fundamental problems, like why after the crisis in 1930s it is happening again in the beginning of 21st century? Why it has not been foreseen in time?

The reasons lay in two main interconnected areas. The first area is the economic sciences, and the prerequisites, on which their methodical instruments for reliable forecast of the economic development are based. The second area is the efficiency of the state (and inter-state) regulation of the development processes in the modern mixed market economy. The way out of the crisis (mostly in the leading market economies of USA, European Union and G-20) is sought mainly in regulating the market processes through different financial regulatory measures. These measures aim to maintain a balance in the financial-credit relations, to limit the number of financial bankruptcies and employment. This, however, is achieved by borrowing a credit on the account of the future development – thus increasing the state debts. The high liabilities of the individuals are added, as well as the large inter-firm indebtedness (particularly of the firms in Bulgaria). Managing this indebtedness should focus on increasing the productivity of the economy in the next years. For this purpose, highly effective and executively reliable development strategies should be elaborated. The immediate problems of the global heating, as well as the problems of maintaining sustainable economic development, create

[*] *Sengupta, S. S., R. A. Ackoff.* System Theory from an Operation Research Point of View. - General Systems, 1965, Vol. X, p. 43-48.

serious obstacles to the outcome of the crisis. The sustainable development of the economy[1] should be achieved through **a *balanced economic growth***.

A little has been done in the first area – the development of the economic sciences. The alarm concerning the unsatisfactory state of these sciences is hopeful. The need of re-evaluating the fundamental prerequisites, on which the methodical instruments for reliable forecast of the economic development are based, is urgent. This alarm is especially revealed in the article of *Anatole Kaletsky*, published in *"The Times"* newspaper. It has been re-printed in *"Class"* newspaper on 28.10.2009.[2] The title of the article is quite intriguing – *"Three Cheers for the Death of Old Economics"*. The author pleads for a more serious debate on three main unconfirmed by the economic development components of the economic sciences existing hitherto. In the models of managing the economy presented by economists, central banks and governments, finances are rarely mentioned. According to the "rational expectations" theory, the "effective markets" do not need stabilizing under the supervision of the governments. Second, these markets always distribute the resources in the most effective way, and present the best available information and future forecasts. Third, from descriptive the economic science should become a branch of the mathematics, using clear suggestions for the human behavior – like the ones in the rational expectations theory.

One of the measures for overcoming the weaknesses of the economic sciences is the creation of the Institute for New Economic Thought (INET). Initially this institute has been financed with 50 million USD by George Soros and "supported by the invincible front of acknowledged academicians economists, aiming to encourage the blossoming of the original thought of each professional, whose artistic skills have been suffocated by the intellectual monopoly of the orthodox academism, financed by different organizations" (quote from the mentioned article).

The inefficient regulatory actions of the governments and central banks are rooted in the context of the mentioned weaknesses of the economic sciences. In this sense, notable is also the article of *David Leonhardt* in *"The New York Times"*, re-printed in *"Class"* newspaper on 07.01.2010,[3] and entitled *"Fed Missed This Bubble. Will It See a New One?"* The article criticizes the Fed's demands for higher regulation of the financial markets. In response to this demand of Ben Bernanke (and his predecessor Alan Greenspan), with the motive that Fed has an unsurpassable team of experts, the author raises the question "Why then these experts have missed the biggest bubble of our time? And will they miss the next one?" According to the author, one of the reasons for this failure is that Fed's experts have not adequately doubted their own suggestions. This goes to the truthfulness of the fundamental prerequisites of the models of forecasting the economic development. Particularly, it is a matter of

[1] See Lisbon Agreement of the European Union, art. 2, p. 3.
[2] http://www.class.bg.
[3] Ibidem.

these prerequisites of the methodical instruments for economic forecast. These instruments include three components supplementing each other:

1. Models for determining the parameters of the development: goals (desired results), limiting conditions for the necessary resources and for their possible volumes – in the form of systems of equations. It is done in the margins of the productivity of the systems, so that the sought variables will not have negative numerical values.

2. Methods (algorithms) for solving the task of the model, as well as software programs for computer realization of these models.

3. System of indicators – number parameters in the models.

In determining the type of methodical instruments, the content prerequisites with axiomatic significance include:

a) Type of the systems – closed or open. According to the classification of Kenneth Boulding,[4] the systems have 9 levels of complexity. The simplest ones (the first 3 levels) are closed systems of the inanimate nature. The others are open systems of the animate nature. Their most common quality is metabolism. More generally, self-organization and self-regulation in maintaining their dynamically changing balance between the input and output. The economic systems are the 8^{th} level of complexity, with elements of those of the 9^{th} level – the systems yet unknown for the science.

b) The number, character and strength of the networks of links and interactions between the elements of the system. The change of these links and interactions determines the new balanced state of the systems. This leads to a change of the productivity of the systems, respectively the ratio between the transfer and added value.

What are the main advantages of the suggested system-structural methodical instruments in the prerequisites for development of the systems, compared with the suggested ones in the economic theory and economic practice? (The criterion for evaluation of these advantages is the reliability of the forecasts for economic development.)

First. The applied instruments are based on the inadequate prerequisite "under equal other conditions" (Ceteris paribus). They are valid for the simple closed systems. The static methodology reads: "The main suggestions for the development processes of the production system are: the content of the development factors is pre-determined, each one of them is internally homogeneous; the technical progress is defined as a clear function of time: a simple re-productivity of structural-technological ratios in this system is assumed, as well as complete commensurability of the factors (costs) and the results of the production-economic activity for different, even quite distant periods, without taking into consideration the occurred quality changes."[5]

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[4] *Boulding, K.* Studies of the General System Theory. Moscow: "Progress", 1969, p. 106-125 (in Russian, translated from English).

[5] *Danilov-Danilian, V. et al.* Forming Long-Term Economic Strategies of the Developing Countries. – Economy and Mathematical Methods, 17.03.1981, p. 499 (in Russian).

In the system-structural instruments for the development of the open systems, their inherent qualities are in action: activity and dynamism, compensatory feedbacks and interactions, ergodicity (change in the qualities of the systems in the process of their development), and productivity (the transfer value of a realized production entity should be less than 1). The mentioned qualities determine the self-organization and self-regulation of these systems.

Second. The speed (rate) of the development in the applied instruments for achieving their goals (production volumes, profits from realization, etc.) is determined by the previous development and is extrapolated to the future. On the other hand, in the system-structural instruments the target requirements concerning the volumes and structure of the realized production are assigned as an initial approximation. This assignment takes into consideration the sustainability of the development of the system inside its productivity. In the iterative process of elaborating the strategic solutions, the mentioned goals are balanced with the necessary resources for their achieving.

Third. The applied instruments do not take into consideration the really quality changes of the economic development. Such changes are mechanically included in the regressive equations for the previous development. This happens through calculating the technical progress coefficient as a time function. The quality changes of the system-structural instruments are formed endogenously in the iterative process of balancing the goals and their supplementing resources (in the changes of the parameters and of the multiplicative and accelerating effects in the transition from one balanced state of the system to another).

Fourth. The input of the system, included in the equation of the regression analysis of the previous development, is a starting point in the applied instruments of the development. On the other hand, the starting point in the suggested instruments is the desired volumes, structure and dynamics of the future development. The resulting direction of the development, determining also the increase of the productivity of the system, dominates.

Fifth. The determining of maximally aggregated averaged parameters in the equation (model) of the regression analysis, which transfer to the future, dominates in the applied instruments. On the other hand, the system-structural instruments work with matrix presentation of the systems, of the type input-output tables but with reversed places – output-input tables. It is done so that the resulting starting point will replace the resource-determined starting point. Also, there the resulting starting point is presented like a desired vector of the realized production (not the target production) – like an expression of the multi-parametric target requirements towards the development.

Sixth. The assuring of comparability and commensurability of the parameters in the system-structural instruments is an important advantage for these instruments. They have a value dimension and they work with constant prices of the base year. The latter is done to eliminate the changes in the prices between the base and the future year. The applied instruments use natural

measurers for the system parameters. Relative numerical characteristics, like correlation coefficients and coefficients for integral structural differences, are calculated for decreasing the scale numerical differences between them. Otherwise, the logarithms of the natural numbers are applied.

Seventh. The matrix forms in the applied instruments help calculating the coefficients of the multi-factor regression equations, using also correlation matrixes. The matrixes in the system-structural instruments in the output-input tables present the value measurers for transfer value and realized production.

An additional weakness of the applied instruments is that they take into consideration only the bi-factor relations and not the multi-factor ones. Also, in the correlation matrixes, the symmetrically positioned correlation coefficients, compared to their prime diagonal, are equal in numerical value. This does not allow considering the multiplicative effects of the reverse compensatory links under and on the prime diagonal. In this way, the changes (quantitative and qualitative) of these relations in the systems development are ignored.

Eight. Reducing the models to regression (correlation) equations (with many aggregated averaged numerical parameters) strongly decreases the diversity of the systems. In this way, the inherent system effect is ignored. It should not be ignored, having in mind that in the period 1972-1976 this effect insures average 33% of the total production growth of the country, for some branches reaching 80%.

Ninth. The system-structural instruments, in the form of RPSD iterative procedure (where R is restructuring, P – productivity, SD – sustainable development), ensure optimization of the system development. This optimization ignores the effects of the alocative, technical and X – organization-coordination effectiveness, and the target vector and the recurrently determined resources (transferred value) for its ensuring are mutually balanced.

The iterative procedure of determining the changing balance (between input and output) of the development of the economic systems and their productive potential has the qualities of acting system-structural instruments for developing a balanced strategy for development of the economic systems. The initial methodical and information instruments include input output tables for the base year, as well as exogenously assigned (expected) growths – decreases of the realized production by sub-branches ΔX (initially assigned) compared with their reached number values in the base year. The inter-branch balancing of the realized production and the transferred value – totally for the economy and particularly for each sub-branch – is determined through implementing the iterative procedure. The latter is a significantly modified version of the RAS method of the Nobel Prize winner Richard Stone. With the iterative procedure the matrix for the base year is iteratively re-balanced into a new inter-branch balanced matrix for the forecast year. It is done for the transferred value – through the exogenously assigned changes of vector S (on the columns of the matrix) and for the production realization – through vector R (on the rows of the

matrix). Matrix *A* is a matrix of the direct material costs (transferred value) of one entity of realized production.

The main change in the iterative procedure, compared with the RAS method, is the exclusion of the diagonal matrix with exogenously assigned elements of vector *S*, as multipliers of the columns of matrix *A*. It has only the diagonal matrix with exogenously assigned elements of vector *R*, as multipliers of the rows of the same matrix, i.e. of the realized production (for more stable calculations the iterative procedure uses the matrix of the inter-branch flows X_{ij}, since $A_{ij} = X_{ij} : X_j$). Besides the mathematical evidence of the similarity of the iterative procedure[6], this modification of the RAS method has a sufficient grounding with rich content:

1. Multiplying of matrix *A* with diagonal matrix R_i with constant multipliers for each row, thus going from one iteration to another, is justified, since it is a realization of homogeneous production. On the contrary, the applying of constant multipliers through the diagonal matrix S_j is pointless, since each element of this column has a different material content, and therefore different price dimension. In the iterative procedure, the initial and iteratively changing from iteration to iteration elements of the diagonal matrix R_i play a leading role. They are determined as indexes between the reached numerical values of the vector of the realized production for the given iteration and those for the previous iteration (in the beginning of the iterative procedure these indexes are determined as exogenously assigned volumes of the realized production X_i^d in the forecast year and actually reached X_i^b in the based year, where *d* is desired volumes in the forecast year and *b* is actually realized volumes in the base year). In this way, in the restructuring and developing of the economy the dominating principle is the production realization as a main postulate of the modern market economy.

2. The transition from iteration to iteration is "charged" by consecutively forming new diagonal matrixes $R_{i1}, R_{i2}, \ldots R_{im}$, where *m* is the last iteration in a row, when the realized production is balanced with the value transferred in it. Their serial numerical values are determined by the corrected volumes of the realized production. The correction represents the differences (with a sign plus for odd and minus for even numbers) of the sums by columns in the column *j*, corresponding to row *i*, i.e. of the given iteration compared with the previous one.

3. The iterative process of the inter-branch balancing of the production, i.e. of the elements of the vector X_i – realized production, ends when the correlations $R_{im} : R_{im-1}$ reach 1 (close to 1), respectively when the differences of the sums of the transferred value (by columns) $S_{jm} - S_{jm-1}$ reach 0 (close to 0).

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[6] *Kovachev, A.* Development of the Economic Systems (System-Structural Approach to the Restructuring, Productivity and Sustainability of the Development). Sofia: University Press "Economy" – Annex 2, 2008.

BLOCK SCHEME of the iterative procedure RPSD

I. Initial (assigned information) for the base year (*b*)

I.1. Volume of realized production – vector Xi^b

I.2. Matrix of production-realization relations Xij^b

II. Information for the forecast year

II.1. Assigned (desired) volumes and structure of the realized production – vector Xi^d.

II.2. Determined by means of the iterative procedure:

II.2.1. Xi^{dm} is vector of the realized production in the forecast year.

II.2.2. The matrix of the production-realization relations Xij^{dm} for the forecast year with iteration *m*

I=J=1, 2, 3 ... n,

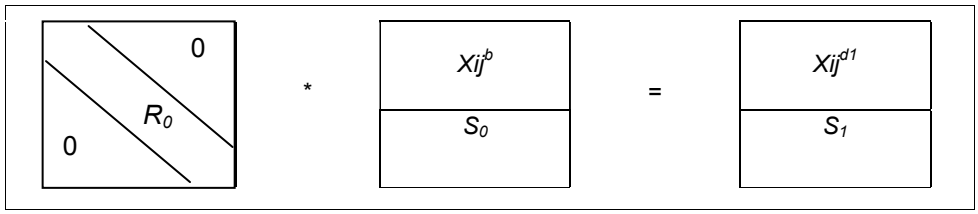
where *n* is the number of elements in the economic system,

d = 1, 2, … m is the number of iterations.

III. Action through iterative procedure

III.1. Initial iteration

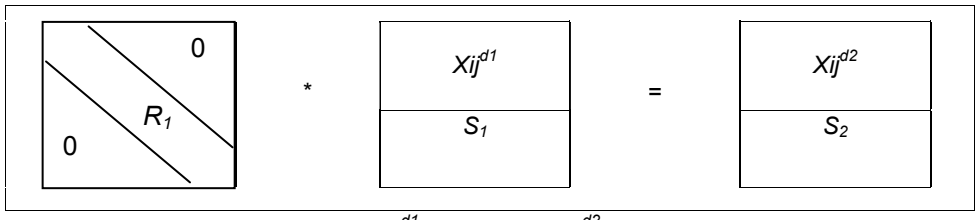
$$Xi^d : Xi^b = R_0$$



$$Xi^d + (S_1 - S_0) = Xi^{d1}$$

III.2. First iteration

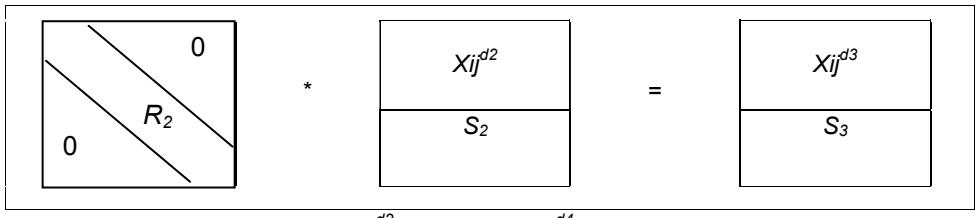
$$Xi^{d1} : Xi^d = R_1$$



$$Xi^{d1} - (S_2 - S_1) = Xi^{d2}$$

III.3. Second iteration

$$Xi^{d2} : Xi^{d1} = R_2$$



$Xi^{d2} + (S_3 - S_2) = Xi^{d4}$, etc.

The optimal strategy (version) of development is determined by $(E - A)\ X \rightarrow Y\ (max)$, respectively with minimization of the determinant of the matrix for the future year with iteration m

$$\prod_{i=1}^{n} (1 - a_{ij}),$$ where $i = j$.

The process of balancing (of the similarity of the algorithm of the iterative procedure) has oscillatory character with progressively decreasing amplitudes, compared with the balance line between the volumes of the realized production and those of the transferred value.

Accuracy of the calculations:

- for 5th iteration – one symbol after the decimal point;
- for 15th iteration – two symbols after the decimal point;
- for 25th iteration – three symbols after the decimal point.

The procedure presented in the scheme has a mathematically proven similarity – in accordance with the condition in section 3.

The iterative procedure presented for determining the inter-branch balanced development of the national economy – for about 90 branches and sub-branches – is realized through a proper program provision. The author has applied this procedure many times in the forecasting, as well as in the retrospective analysis of its restructuring and development.

Even though there is no explicitly formulated optimal criterion in the model for this procedure, the minimization of the determinant of the E-A matrix (generated iteratively) for the future year plays such a role. This matrix represents the difference between the realized production (as a desired vector) and the transfer value of the input. The version with preferred volume and structure of this production and minimal numerical value of the mentioned determinant is the optimal version of the strategic development as well.

The difference between the total values of the realized production vector of the versions with highest and lowest determinant of E-A matrix, determines ***the zone of the balanced sustainability of the system***, respectively the upper and low border for its productivity.

Tenth. The numerical value of the determinant of the matrix *E-A* for the forecast year of the optimal version of the strategy and the lowest value version, are compared with the value of the determinant of the same matrix for the base year. Thus, the growth effects are determined for the whole system between the two years. This effect can be differentiated by branches (elements of the system) through dividing the growth of the value added to the relevant growths of the transferred value. However, this way determines the direct effects. For determining the full effects (estimated from the point of view of the whole system), the indirect effects are also added. They are determined by the interaction with the other branches. For determining the full effects for each branch, the summed values by columns of the reverse *E-A* matrix for the forecast year are divided to the ones for the base year. The full effects show the changes of the

direct and indirect used production – per production entity for final consumption (the latter being another, isomorphous expression of the value added).

The priorities for developing versions of development strategies should be specified based on the mentioned system-determined full effects. They should be used particularly in determining the initial number values of the desired vector for the realized production in the forecast year.

Eleventh. Through the mentioned iterative procedure, as a synthesis of the system-structural instruments for determining the system development, the trajectory of this development can be determined for each year of the future period. This happens by beginning from the end year of this period as a starting point for determining the development in the year before the last, and going further to the other previous years, including the second after the base one.

Twelfth. The richness of endogenous results of the application of the system-structural instruments is its big advantage. In the set output-input matrix for the base year and desired vector of realized production, the final volumes and structure of this vector are endogenously determined, as well as the whole output-input matrix in the future year. In this way, the necessary resources (domestic and imported, including the necessary investments) are determined, more particularly the size of their transfer value. Thus, the integrated result of the three types of effectiveness is realized, and the minimization of the determinant of the E-A matrix is the synthesizing criterion for this.

In the transition from one iteration to another in the RPSD iterative procedure, system non-linear differential equations are solved. So the volumes of the transfer value are determined recurrently, i.e. as a consequence of the volumes and structure of the vector of realized production.[7]

As a generalization of the mentioned fundamental advantages of the system-structural methodical instruments for elaborating the strategic solution of the development, the following can be stated:

These instruments are specified in the RPSD iterative procedure as a model-algorithm tool for matrix and not linear averaged determination of the development parameters. These future development parameters are generated through “boosting” the output-input matrix of the inter-branch flows X_{ij} (where *i* is consumed production of branch *i* for producing production in branch *j*) and the volumes of the realized production of branch *i* (vector *Xi*) for the base year. In this way, the analog balancing matrix for the future year is generated. When elaborating the development trajectory, the work is done in the opposite direction – for the previous compared to future years. In this case, there is a “shrinking” of the matrix.

The RPSD iterative procedure, with its proven application with model-algorithm ability, can be used also for balancing the indexes of changing the prices of the realized production by branches and sub-branches between the base and

[7] In his article Anatole Kaletsky mentions the use of new mathematical techniques of the non-linear dynamics as a possible direction for increasing the reliability of the model-determined forecasts.

the future year. For this purpose, instead of setting the vector with the indexes of realized production in the future compared to the base year, the vector of indexes of price change is set. Such calculations have been made by the method of forecast in the past – for the period 1981-1985. The diversions from the mutual balance of the prices have turned out quite substantial.[8]

In a similar way, the changes of the size of the main components (observed elements) of the ecological pollutions can be evaluated. The same can be done for the balanced binding of the debit-credit relations. The strict restrictions in the resources and the changing scale parameters of the target function, set in the methods of linear optimization, can be overcome through these instruments. It is important when optimizing the development processes.

Through the change of places in the input-output tables matrix and the model-algorithm realization using iterative procedure (balancing the realized production and the transfer value) in the endogenously determined output-input matrix for the future year, the reliable use of input-output model for the purposes of forecast and development becomes practically possible.

At the end, the presented advantages of the system-structural methodical instruments create principally new forecast opportunities for the development – as a further development of the achievements of the Nobel Prize winners in Economics in this area in the 1970s (Wassily Leontieff, Leonid Kantorovich, Tjalling Koopmans and Richard Stone), valid for the static structure-indifferent positions of the systems.

The necessary conditions for RPSD application of the iterative algorithm of the systems development are the following:

- Output-input table of National Statistical Institute (NSI) for the base year – 59 branches (groups of similar products) each.
- Determining the vector of the desired volumes and structure of realized production (as an initial approximation – a starting point of the iterative process). This determining follows adopted priorities and aims at overcoming established structural disproportions, and more generally – increasing the organization (maturity level) and productivity of the economy.
- Applying the necessary software program for computer calculations through iterative algorithm.[9]

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[8] *Kovachev, A.* Management of Economy. Sofia: "Ciela", 2005, p. 181 (in Bulgarian).

[9] *Kovachev, A*. Development of the Economic Systems (System-Structural Transition to Restructuring, Productivity and Sustainability of the Development). Sofia: "Economy", 2008 (in Bulgarian).