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Some Problems of Polymetric Modeling in the Econometrics

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***Abstract* — Basic problems of modeling in econometrics are discussed. An econometrics in its historical development is analyzed. Problem of interference physical and economical laws is observed. Basic notions of Polymetrical Analysis are represented. Possible development and applications of this concept in econometrics are discussed too.**

***Index Terms*— de Broglie formula, econometrics, Hicks laws, Le Chatelier – Samuelson principle, open systems, Polymetric Analysis.**

I. INTRODUCTION

Econometrics is called the science, which researches the quantitative and qualitative economical mutual bonds with help mathematical and statistical methods and models [1-8].

Modern definition of econometrics was made in the statute of Econometric Society. According to this document basic problems of econometrics are using of statistics and mathematics for the development the economics theory. But strongly speaking modern statistics is the chapter of modern mathematics tautology. Theoretical econometrics described a statistical properties of estimations and tests. Applied econometrics is using the application of econometric methods for test of economical theories.

Econometrics gives tooling for the economical measurements, and method of the estimation the basic parameters of micro and macroeconomics. In addition, econometric is used for the prognostication of economical processes in economics in whole and for the unit organization. Wherein econometrics is the chapter of economical theory, other chapters – micro and macroeconomics.

Notion «econometrics» included two chapters: «econo» – «economics» and «metrics» – «measurement».

Microeconomics [4] (from Greek prefix mikro- meaning "small@ + economics) is a branch of economics that studies the behaviour of individuals and firms in making decisions regarding the allocation of scarce resources and the inyeractions among this individuals and firms.

Macroeconomics [4] is a branch of economics that studies how an overall economy – the market systems that operate on a large scale – behaves. Macroeconomics studies economy-wide phenomena such as inflation, price levels, rate of economic growth, national income, gross domestic product (GDP), and change in unemployment.

Therefore econometrics may be represented as theoretical science, which was created for the resolution and estimation all possible economical problems. It may be represented as economical metascience [1]. Its role in economics is analogous to role of mathematical and theoretical physics in physics.

Now we must include in economics ecological, medicine and other problems. But these problems may be cause of expansion of economic theories or synthesis econometrics with other sciences [9, 10]. Examples of such synthesis are cybernetics [11] and polymetric analysis [12, 13].

Therefore we must observe and show the problem of creation econometrics as universal economical theory and its bonds with other branches of modern science.

II. SHORT HISTORICAL REVIEW

First attempts of quantitative research in economics were in XVII century [2, 4, 6]. They were connected with political arithmetic. W. Petty, Ch. Dauvenant, H. King used a concrete economical data for the calculation of national income. This reseaches are caused the search of economical laws analogously to physical, astronomical and other natural science laws. The existence of an uncertainty did not include.

Important stage of creation the econometrics was development of economical theory by F. Halton, K. Pirson and F. Edgeworth as authors of applied statistical methods [8]. These scientists are determined first applications of pair correlations. For example, G. U. Yule determined bond between level of poverty and forms of help for poor men. G. Hooker measured bond between level of marriage and general welfare [2, 4]. He used some indicators of general welfare and researched temporal series of economical variable quantity.

From 1830 years advanced countries was exposed to economical phenomena (decreasing of business activity, mass unemployment), which couldn't be explain with help existinf economical theories. A rapid expansion of the industry and urbanization showed a see to unresolved social problems. Therefore in end of XIX century neoclassic theory couldn't explain the observable economical processes. For its practical application the basic economical terms must be have quantitative presentation.

In 1911 H. L. Moore published book «Laws of salary: essay of statistical economics". Roughly speaking it is first econometric book [2, 4]. In this book H. L. Moore analyzed the market of labour, statistically revised J. M. Clark efficiency theory and represented basis the strategy for the consolidation of proletariat. He showed that with help complex mathematical models, which are based on experimental data, the theory for social politics may be created. In this time R. Benigni used the set regression for the estimation of demand function [2, 4].

A significant contribution in development of econometrics had observation its cyclicity. It is: 7 – 11 years circles of

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investment (C. Juglar); 3 – 5 years circles of renewal circulating assets (J. Kitchin); 15 – 20 years circles in building (S. Kuznets, 1971); 45 – 60 years “long waves” (N. Kondrat’ev) [2, 4].

Many models have “biological” nature (Logistic equations) [14, 15]. Among them: Ridenur model (exponential law of growth as general law of technical-economical growth); Hartmann model (the rate of change the information in nthe process of development is proportional to the total amount of already accumulated information); Holton model and other. A generalized model of scientific-technologicasl progress was developed by Floyd [14, 15]. The main idea of the model is to calculate the probabikity of improving the efficiency of the system depending on the efforts of scientists and specialists [14, 15].

Large value in development of econometrics has production function [14, 15]. The production function shows how output depends on the cost of different type of resources for a given technology. In aggregate top-level models two ntypes are usually chosen as resources: fixed assets of the system; living labor resources (labor) [14, 15].

The production function that establishes this relationship has the form

$$Y = F\left(K, L\right), \tag{1}$$

where Y – output (gross product) of the system; K – volume of fix assets; L – volume of living labor (labor force) [].

The production function has the following properties:

1) continuity and convertibility to zero;
2) additively;
3) divisibility;
4) monotony;
5) differentiation. The production function is twice differentiable with declining growth rates.

Characteristics that determine the production function are next [14, 15]:

1. Coefficients of elasticity the system output on input resources. These coefficients show how many perecent the gross product will change if the volume of corresponding resource (factor) is increased by one percent.
2. An elasticity of system re[placement.
3. Homogeneity of production function.

As result general differential equation for the determination of product function were received.

Depending on the additional conditions, a suitable production function can be obtained. Here some of them: Leontiev’s production function [16]; Cobb-Douglas production function [14, 15].

This method was used for the description of scientific and technological progress (STP), which will be manifested in the replacement of one technology by another. Three types of exogenous neutral processes were received: Hicks neutral STP [17]; Harrod neutral STP [18] and Solow neutral STP [19, 20].

Methods of thermodynamically theory of phase transitions, synergetic methods and catastrophe theory were used for the resolution economical problems too. So, we can have phase transition fifth and sixth order [14], in physics maximal order of phase transition is three (superfluidity) [21].

An important stage in the formation of econometrics was the construction of economic barometers. The construction of economic barometers is based on the idea that there are indicators that change earlier than others and therefore can serve as signals for changes in the latter. The first and most famous was the Harvard barometer, which was created in 1903 under the leadership of W. Persons and W. Mitchell [2, 4]. It consisted of curves characterizing the stock, commodity and money markets. Each of these curves was the arithmetic mean of several indicators included in it. These series were pre-processed by eliminating the trend, seasonality and reducing the fluctuations of individual curves to a comparable scale of oscillation. The success of using the Harvard barometer caused the appearance of many similar barometers in other countries. However, since about 1925 he lost his sensitivity. Its collapse is due to the emergence of a powerful regulatory factor in the US economy. Under these conditions, the main method of macroeconomic analysis becomes the method of constructing the interindustry balance of W. Leontief [16]. At the same time, economic models using harmonic analysis methods began to be built. These methods have been transferred to economics from astronomy, meteorology and physics [2, 4].

By the 1930, all the prerequisites for separating econometrics into a separate science had developed. It became clear that for a deeper understanding of economic processes it is worth using to one degree or another statistics and mathematics. There was a need for the emergence of a new science with its subject and method, combining all research in this direction. On December 29, 1930, at the initiative of I. Fischer, R. Frisch, J. Tinbergen, J. Schumpeter, O. Anderson and other scientists, an econometric society was created. In 1933, R. Frisch founded the journal Econometrics, which even now is of great importance for the development of econometrics. And already in 1941, the first textbook on a new scientific discipline appeared, written by J. Tinbergen [2, 4]. In 1969, Frisch and Tinbergen became the first researchers to receive the Nobel Prize in economics. As stated in the official message of the Nobel Committee: "for the creation and application of dynamic models to the analysis of economic processes."

Statistical methods played an important r ole in the development of econometrics [2, 4, 22, 23].

Until the 1970th, econometrics was understood as an empirical assessment of models created in the framework of economic theory. According to econometricians of the time, statistics were supposed to protect the theory from. Moreover, the vast majority of economic models built during this period were Keynesian. But starting in the 1970th, formal methods began to be used in choosing causality of theoretical concepts. At the same time, monetarists began to actively use econometrics [2, 4, 5].

In 1980, American economist Lawrence Klein received the second econometric Nobel Prize in economics for creating economic models and their application to the analysis of economic fluctuations and economic policy. Together with A. Goldberg, he created one of the most famous models of the American economy, known as the "Klein – Goldberg model." The structure of this model was based on his own development. It consisted of directed series of equations, the solution of which gave a picture of production in the country. Speaking of this model, R.J. Ball: “As an empirical idea of the foundations of the Keynesian system, this model became perhaps the most famous among the models of large national farms before the advent of other models in the 60th.” [2,4]. Klein also organized the well-known Link project to integrate statistical models of different countries into a single common system in order to improve understanding of international economic relations and forecasting in the field of world trade [2, 4, 5]. At this time, not only macro, but microeconometrics was actively developing. The pioneers of this trend were J. Heckman and D. McFadden. They developed the theory and methods that are widely used in statistical analysis of the behavior of individuals and households both in the economy and in other social sciences. So, J. Hekman solved the problem of sample bias due to data selectivity and self-selection. To solve it, he proposed using the Heckman correction method, which, due to its efficiency and ease of use, has become widely used in empirical research. The main contribution of D. McFadden to science is the development of methods for the analysis of discrete choice. In 1974, he developed a conditional logit analysis, which was immediately recognized as a fundamental achievement of economic science. He also created econometric methods for evaluating production technologies and researching the factors underlying firms' demand for capital and labor. The outstanding achievements of these scientists were awarded the Nobel Prize in Economics in 1990 [2, 4, 5].

An important event for the development of econometrics was the emergence of computers. Thanks to them, the statistical analysis of time series has received powerful development. J. Box and G. Jenkins created the ARIMA model in 1970, and C. Sims and some other scientists created the VAR models in the early 1980s. Stimulated econometric research and the rapid development of financial markets and derivatives. This led the 1981 Nobel Prize winner in economics J. Tobin to develop models using censored data [2, 4, 5].

T. Haavelmo also had a great influence on modern econometrics. He showed how one can use the methods of mathematical statistics in order to obtain sound conclusions about complex economic relationships based on a random sample of empirical observations. These methods can also be used to evaluate relationships derived from economic theories and to test these theories. In 1989, he was awarded the Nobel Prize in Economics “for clarifying the probabilistic foundations of econometrics and analyzing simultaneous economic structures” [2, 4, 5].

T. Haavelmo regarded economic series as the realization of random processes. The main problems that arise when working with such data are unsteadiness and strong volatility. If the variables are non-stationary, then there is a risk of establishing a connection where it does not exist. An option to solve this problem is the transition from the levels of the series to their differences. The disadvantage of this method is the complexity of the economic interpretation of the results. To solve this problem, Clive Granger introduced the concept of cointegration as a stationary combination between non-stationary variables. He was offered a model of correction of deviations (ECM), for which he developed methods for estimating its parameters, generalization and testing. Cointegration is applied if the short-term dynamics reflect significant destabilizing factors, and the long-term strives for economic equilibrium. The models created by Granger were generalized by S. Johansen in the multidimensional case in 1990. In 2003, Granger, together with R. Engle, received the Nobel Prize. R. Engle, in turn, is known as the creator of models with time-varying volatility (the so-called ARCH models). These models are widely used in financial markets [2, 4, 5].

Large value on the development of modern econometrics had matrix algebra and methods of linear programming [24].

III. SOME LAWS OF ECONOMETRICS AND ITS EXPANSION

As an example of using the polymetric method, we give a generalized econometric analysis. Compared to physics and information theory, this science seems simpler, but if that were the case then there would not be so many social cataclysms that so often affect the history of mankind [1, 12].

Classical econometrics [1] mainly includes methods of statistical and factor analysis, and the laws of the Walras-Leontief type (evolution systems) [1, 16, 26] and von Neumann-Marx type ("revolutionary" systems) [1, 25]. However, the current level of development of society requires more advanced theories, as evidenced by the study B. Havrylyshyn [9]. In the modern economy, it is imperative to take into account such factors as ecology, sociology, psychology, etc., that is, a fertile field for the use of a polymetric approach.

First we introduce a new terminology [1, 27, 28]:

z_i – total output of the i-th industry;

z_{ij} – total output of the i-th industry, which is consumed by j-th industry;

c_i – demand for the i-th product;

a_{ij} – constant coefficients of cost of the i-th product per unit of output j-th industry;

ω – salary;

q_i – profit per unit of output in the second-area industry;

$a_{n+1,i}$ – coefficients of labor costs in the i-th industry.

The system of equations of balance and outputs of all products in systems of the Leontief type may be represented as [1, 27, 28]:

$$z_i = \sum_{j=1}^{n} a_{ij} z_j + c_i ; (i = 1...n). \quad (2)$$

System of equations of balance of prices, wages and profits is next:

$$p_i = \sum_{j=1}^{n} a_{ji} p_j + a_{n+1,i}\omega + q_i ; (i = 1,...n). \quad (3)$$

In systems of the Leontief type there is a twin between outputs and prices in the sense that the matrix of coefficients { a_{ij} } of the subsystem for determining prices is obtained by transposing the matrix { a_{ij} } subsystem for the determination of issues. Both subsystems have common algebraic properties, so you can use one half of the equations in the future.

Leontief system [16] is a partial case of the general equilibrium system of Walras [26], consisting of four groups of equations [1, 27, 28]:

I – functions of the market offer for goods;

II – functions of market demand for goods;

III `–query and supply equations for goods and factors;

IV – equations that connect prices to production costs.

In the Walras model, the propositional functions for the factors and the query function for goods are given by the theory of marginal utility in terms of prices. In the Leontief model there are no analogues for these functions, since the vector of final demand ($c_1, ... c_n$, ...) and the newly created costs $(a_{n+1,1}\omega + q_1, ... a_{n+1,n}\omega + q_n)$ are parameters. Issues are determined independently of the prices given by the cost price equations. This independence and the assumption of the continuity of the technical coefficients lead to the simplicity of the Leontief model.

We give the basic laws of equilibrium econometrics [1, 12, 27, 28].

The first Hicks law. The excess demand from the zero product to the *j*-th causes an increase of the relation the equilibrium price of the *j* product to the equilibrium price of the zero product, except in the case when the product *j* is free.

The second and third Hicks laws in a weak form [1, 12, 16]. In the result of the shift of priorities from zero product to *j*-th in the indeterminate system $\mathbf{1}'$, the ratio of the price of any product to the price of zero product does not decrease; besides, there is no product for which this ratio would have increased in a larger proportion, as for the *j*-th commodity.

The second and third Hicks laws in a strong form [1, 12, 16]. As a result of shifting the priorities from the zero product to the *j*-th in a highly undisturbed system, the equilibrium price of any product in relation to the price of zero commodity increases in a smaller proportion than the price of the *j*-th commodity.

The Principle of le Chatelier – Samuelson [1, 21]. Let the condition of strong gross substitutability be fulfilled. The increase in the price of any product with the number $j > m$ due to the shift of priorities, by changing the query of the zero product to the *j*-th (where $j > m$), for the case when the prices of all goods with numbers (1, ... *m*) are maintained constant (due to the adaptation of the offer of each these products) is less than the growth of the price of the same commodity with the same shift of priorities for the case when the offer of one of the mentioned n goods, say, a commodity with the number *m*, is not adapted and, accordingly, the price of the *m* commodity may change.

The principle of le Chatelier-Samuelson was created analogously to thermodynamically **Principle of le Chatelier-Brown [6, 29]**: if a system in stable equilibrium is influenced from the noutside by changing any of equilibrium conditions (temperatyure, pressure, concentration, external electromagnetic field), then processes directed towards counteracting the changes are amplified in the system [].

In addition to equilibrium econometric models there are also models of economic growth. These are the models of Smith, von Neumann, Kondratiev, and others. However, in order to illustrate the possibility of applying a polymetric approach to econometrics, we will have enough equilibrium case [1, 12, 15].

Now let's consider how it is possible in this case to proceed to representations of the polymetric measure [27, 28]. We take the first half of the equations (2) of the Leontief model. We introduce inverse econometric parameters [12, 27, 28]:

$$k_i = \frac{N_1}{z_i}; b_i = \frac{N_2}{c_i}; y_{ij} = \frac{N_3}{a_i z_{ij}}. \tag{4}$$

Generalized econometric parameters then have the form:

$$k_{ij} = k_i z_j; B_{ij} = b_i c_j; Y_{ij} = z_j y_{ij}. \tag{5}$$

In general

$$k_{ij} = \begin{cases} N_1; i = j \\ f_1(k_i, z_j); i \neq j, \end{cases} \tag{6a}$$

$$B_{ij} = \begin{cases} N_2; i = j \\ f_2(b_i, c_j); i \neq j, \end{cases} \tag{6b}$$

$$Y_{ij} = \begin{cases} N_3; i = j \\ f_3(z_{ij}; y_{mn}); i \neq m; j \neq n. \end{cases} \tag{6c}$$

A generalized econometric equation can be written as follows:

$$F(k_{ij}) = F_1(Y_{ij}) + F_2(B_{ij}), \tag{7}$$

where F_i – functional dependence.

In the linear case:

$$k_{ij} = Y_{ij} + B_{ij} \tag{8}$$

or

$$k_i z_j = z_{ij} y_{mn} + b_i c_j. \tag{9}$$

For $i = j = m = n$ we have

$$kz = \tilde{z}y + bc. \tag{10}$$

Minimizing these ratios we will get:

$$\frac{dz}{dy} = \frac{d\tilde{z}}{dk} = A_1; \quad \frac{dk}{db} = \frac{dc}{dz} = A_2; \quad \frac{d\tilde{z}}{db} = -\frac{dc}{dy} = A_3. \tag{11}$$

After solving these equations we will be obtained

$$\begin{aligned} z = z_0 + A_1 y; \quad c = c_0 + A_2 z; \\ \tilde{z} = \tilde{z}_0 + A_1 k; \quad \tilde{z} = \tilde{z}_0 + A_3 b; \\ k = k_0 + A_2 b; \quad c = c_o - A_3 y. \end{aligned} \tag{12}$$

That is, we have linear laws for preserving the amount of costs, demand and inverse quantities. These laws are truie in a specific area. As is easily seen, the relation (12) is also a linear generalization of the Hicks laws and the principle of le Chatelier – Samuelson [12, 27, 28].

More complex dependencies are obtained from the next relationship

$$dk \cdot dz = d\tilde{z} \cdot dy + db \cdot dc \tag{13}$$

or in a generalized form –

$$dk_{ij} = dY_{ij} + dB_{ij}. \tag{14}$$

From the equation (13) in a simplified form we can obtain a correlation

$$dk \cdot dz = d\tilde{z} \cdot dy + L_1, \tag{15a}$$

$$dk \cdot dz = db \cdot dc + L_2, \tag{15b}$$

$$d\tilde{z} \cdot dy = db \cdot dc + L_3, \tag{15c}$$

where L_1, L_2, L_3 – constants.

Solutions of the equations (15) are more complicated than the solution of equations (11) – (12). In general, they have the form:

$$k = k_0 + A_1 y; \tilde{z} = \tilde{z}_0 + \tilde{A}_1 F(L_1, z) + \tilde{A}_1' F_2(L_1, z, y). \qquad (16)$$

That is, in the relations of type (3.118), unlike the relations (12), we can take into account small changes of any of the econometric parameters. Equations of type (13) yield Volterra-type equations, as well as a more complex type equation. That is, based on equilibrium conditions, dynamic systems can be described: to investigate both economic growth and decline.

By changing the number of corresponding quadratic members in the equation, we can introduce additional factors that affect the economy, including environmental factors, psychology, etc. Many of them can be taken into account with the help of generalized mathematical transformations. For a more complete modeling of such econometric models, you need to use a computer [27, 28].

Further unifications of econometric laws maybe received from the formal analogy between action and entropy in physics [3] and using this result for the creation universal theory of open system and transition on all possible information theories, including econometrics.

The main task is to understand the meaning that these values will have in wave mechanics and to associate them with the fundamental parameters of atomic level particles, such as mass, frequency or wavelength.

De Broglie's attempt to establish this relationship is very similar to his first thoughts on wave-corpuscular dualism. Let us dwell now on this approach. In wave mechanics, with every particle of mass m, a periodic phenomenon of frequency ν is connected. To express this relation quantitatively, where Broglie compares the Einstein formula $E = mc^2$ with Planck formula $h\nu$ and deduces the equality [30]

$$mc^2 = h\nu, \qquad (17)$$

which in the most general form reflects the correspondence between the postulate of quanta and the principle of relativity.

To satisfy the principle of relativity – means to demand that the law be the same for all observers, who are in a straightforward uniform motion relative to each other. However, neither mass nor frequency is what is called relativistic invariants, that is, values that do not vary from one observer to another. It is necessary that both of them change in the same way so that the equality in which they enter can be preserved, which leads to serious difficulties.

Wave mechanics appeared, in a sense, with de Broglie theorem, according to which everything proceeds as if there was a wave propagating at a much higher speed than a particle, and which is a standing wave with frequency 0 for the observer being in a state of rest, and every other observer always sees it in the phase with the internal cyclic motion of a particle. De Broglie showed that the frequency of such a wave varies from one observer to another as well as mass, and hence it follows that the quantum relation (3.185) will be relativistic covariant when we replace it with a cyclic frequency, which we denote by ν_c to the frequency of this wave.

Let's consider thermodynamics. As shown by M. Plank, A. Einsteyn, M. Laue, its principles are influenced by the principle of relativity. For example, when entropy is relativistic invariant, that is, it has the same value for all observers, and then the temperature and heat should be considered differently. When an observer in a state of rest relative to the physical system exchanges with it a certain amount of heat Q_0 at a temperature T_0, then another observer moving relative to the first uniformly and rectilinear will fix the amount of heat Q and temperature T which will be less than Q_0 and T_0 . Both the temperature and the heat vary equally, but opposite to energy or mass, despite the fact that heat is a form of energy. But the nature of the temperature change is the same as for the cyclic frequency ν_0, and de Broglie attached great importance to this [12, 30].

Even R. Clauzius and L. Boltzmann [12, 30] understood that when it is possible to interpret heat as an unregulated part of energy, then the difference between heat and work is mainly due to the difference between two types of movements, one of which is rapid and chaotic, and second slow and orderly. As a result, the thermodynamic analogy is observed in phenomena that have no relation to thermodynamics.

Thus, we see that an analogy is established between the calorific energy of the gas and the energy of the fluctuation of the string, the analogy is so deep that Clauzius and Boltzmann were able to even calculate the increase in the "heat" of the string by slipping the finger and found that it is equal to the product of the frequency of the stationary fluctuations on the mechanical gain a quantity which is related to the average energy of oscillation and which is called an action. It is this formula that serves as the starting point of the thermodynamics of an isolated point (particle). When a particle is a source of periodic motion, it can indeed be attributed to the cyclic frequency ν_c, which we already know. It can also be attributed to the "action", and the Clauzius-Boltzmann formula allows you to express the amount of heat that the particle exchanges with the environment. But the same amount of heat is expressed by the function of entropy and temperature, the main Clausius formula, which in fact is a thermodynamic definition of entropy. Therefore, the relationship between the action S and the cyclic frequency ν_c, on the one hand, and the entropy of S_e and temperature T, on the other, must exist. de Broglie [30] expressed the following formulas:

$$h\nu_c = kT, \qquad (18a)$$

$$S/h = S_e/k_B, \qquad (18b)$$

where k_B – Boltzmann constant.

Here we arrive at the principle of relativity. Since the cyclic frequency and temperature vary equally from one observer to another, the law written in formula (18a) will be the same for all observers. One can show that the same will be the case with relation (3.186b), and from here we can conclude that thermodynamics that controls the heat exchange between a particle and a subquantum environment does not give privileges to any observer. The air thus determined does not allow to distinguish the absolute motion and does not contradict the principle of relativity.

The formulas (18b) describe those phenomena that occur quite slowly near the state of the thermodynamic equilibrium. Therefore, these states naturally coincide with the stationary states of wave mechanics. But one can extrapolate these calculations to a more general case where such a balance, and hence stationary state, does not occur. The Carnot principle [30] shows that the entropy of the system must go to a state of stable equilibrium, that is, to a quantum state. It follows that when stationary states are not the only possible states, they are, because of their thermodynamic stability, realized with a higher probability. Since the electron is always of great disturbance, it will always fluctuate near one of its aggregate states, when only a greater disturbance does not disturb the equilibrium. In the latter case, the electron will move to another stationary state as a result of the transient process, which can be described in space and time [3].

It should be noted that the relations (18) have a wider meaning than those given above. Namely, these relations practically correspond to a single ordered and disordered movement and practically show that for a stationary state the order of magnitude of the motion is equal to the degree of disordered.

Let's note the next. Thermodynamics of isolated particle can lead to such synthesis. It can be shown that when a particle is in constant contact with a thermal reservoir formed by a subquantum medium, then the action with (18) should be close to not entropy, and to another thermodynamic function with similar properties, namely to free energy. In contrast to entropy, this function, according to Carnot principle, should be minimal for stable states, and where de Broglie was able to give its expression in wave mechanics.

Further synthesis in physics, obviously, is expedient to carry through the expansion and its connection with the theory of information. For the first time in detail it was disassembled by L. Brillouin [31].

To do this, we need to consider the negentropic principle of information in more detail. There are two types of information:

1. free information I_f, which arises when possible cases are considered abstract and as not having a specific physical meaning;
2. coupled information I_b, which arises when possible cases can be presented as microscopes of the physical system. Thus, the linked information is a partial case from the free one.

The basis for entering this cancellation is that we are going to discuss the connection between information and entropy (and its opposite – negentropy), and we will use the term "negentropy" only in the generally accepted thermodynamic sense. Thus, only the information that arises in certain physical tasks, that is, the information given will be provided with entropy.

It is obvious that in this scheme the system is not isolated: the entropy decreases with the receipt of information, which reduces the number of microspheres, and this information must be delivered by an external agent whose entropy will increase. The connection between the decrease in entropy and the required information is obvious [31]:

$$I_{b_1} = k_B \cdot (\ln P - \ln P_0) = S_{e0} - I_{b1}, \tag{19}$$

or

$$S_{e1} = S_{e0} - I_{b1}. \tag{20}$$

Linked information appears as a negative component of a certain entropy of the physical system, and from this we conclude that

Related information = decrease in entropy S_e =
= increase in negentropy N (21)

where negentropy is defined as negative entropy.

This provision is a non-aggressive law of information. We will discuss this relationship in a number of examples and show how information can be converted into negentropy, and vice versa [31].

For free information, it's better not to talk about the relationship between information and entropy, because the relation between entropy and the number of cases is determined only when the cases considered are microsystems of the physical system. Let's now consider the generalization of Carnot principle [31]. When we isolate the system, then according to Carnot principle, in any natural further evolution of the system

$$\Delta S_{e1} \geq 0;\ \Delta(S_{e1} - I_{b1}) \geq 0. \tag{22}$$

Entropy can grow at the expense of both S_{e0} and I_{b1} or either of both. When the system is isolated and provided to itself, it, of course, goes to the most probable medium structure that meets the physical conditions determined by the fixed values of some macroscopic parameters (volume, energy, chemical composition, etc.).

Consider the case when S_0 corresponds to the general structure obtained as a result of the free evolution of the isolated system, so that I_{b1} is not over-defined. In this problem, S_0 remains constant and (22) reduces to

$$\Delta I_{b1} \geq 0, \tag{22a}$$

$$N = -S;\ \Delta N_1 \leq 0;\ \Delta(N_0 + I_{b1}) \leq 0, \tag{23}$$

if $\Delta I_{b1} \leq 0$, when the initial state is not defined. Using negentropy as a measure of energy quality, we obtain the Kelvin energy degradation principle, which is expressed symbolically by equality (23).

Equality is obtained for inverse transformations, while non-verbone transforms give inequalities [31].

The fact that $\Delta I_{b1} \leq 0$ is in accordance with the previously obtained result relating to free information, namely

$$\Delta I_f \leq 0. \qquad (24)$$

This correlation is obtained by proving that the information (free, because the characters are considered abstract and not considered as microsystems of the physical system) has a maximum of even cases.

We can write (22) in the form of an inverse reaction

$$I \leftrightarrow N. \qquad (25)$$

This statement leads to a generalization of the Carnot principle, if we include both types of information [31]. When

$$\Delta I_f \leq 0; \;\; \Delta N_1 \leq 0$$

then

$$\Delta I_f + \Delta N_1 \leq 0,$$

or

$$\Delta(S_{e1} - I_{\text{f}}) = \Delta(S_{e0} - I_{b1} - I_{\text{f}}) = \Delta(S_0 - I) \geq 0, \quad (26)$$

if the consideration includes both linked and free information.

The principle of degradation is expressed through negentropy with inequality

$$\Delta(N_0 + I) \leq 0. \quad (27)$$

The value of N_0 is the negentropy of some physical system.

Based on the formulas (23) and (24) the analogy between thermodynamics and information theory were received.

It should be noted that any theory is informational, including physical. Therefore, it is quite clear that the basic laws of physics one way or another should also include information laws. However, nowadays we have practically only one common information law – this is a negentropic principle of information.

Let's approach to this problem in terms of a polymetric measure. Here is a well-known Rayleygh ratio in one-dimensional form:

$$\Delta k \cdot \Delta x = \Delta\omega \Delta t = 1. \qquad (28a)$$

When multiplying this relation by h (Planck constant) and changing the sign of equality to a sign greater than-equal, then we have

$$\Delta p \cdot \Delta x = \Delta E \cdot \Delta t \geq h. \qquad (28b)$$

It is nothing more than a mathematical expression of the principle of complementarity and of the uncertainty principle.

Recall that the relation (27) is a condition of observation of a unit wave. In the theory of information-physical structures, it is considered as a quantum of change of dimensionless physical measure [].

Thus, the relation (28), which is analogous to the Rayleygh ratio, can be regarded as a spatial-temporal representation of dimensionless entropy, as well as dimensionless action. They are equivalent according to the de Broglie ratio

$$\frac{S_a}{\hbar} = \frac{S_e}{k_B} = S_g, \qquad (29)$$

about the equality of ordered and disordered information in closed system. Here S_a is an action, S_e – entropy, S_g – a quantity of “quantum” the ordered and disorder information in closed system or dimensionless measure. Therefore, it makes sense to consider dimensionless relations not as elements of dimensionless entropy or action, but as elements of a generalized measure [294].

According to [294], we introduce the concept of vacuum from a polymetric analysis.

Definition 3.43. A generalized vacuum is the state of a system in which the change of the generalized measure is zero.

From the latter, the role of the principle of dynamic equilibrium is very clearly visible: it is the principle of equilibrium between physics and information. Entropical representations and the principle of dynamic equilibrium itself can be summarized as follows (for a generalized measure we denote S_g):

$$\delta S_g > 0; \qquad S_g > 0; \quad (30)$$

$$\delta S_g < 0; \qquad S_g < 0; \quad (31)$$

$$\delta S_g = 0; \qquad S_g = 0; \quad (32)$$

The relation (30) is nothing more than the action principle, the Carnot principle, the uncertainty principle and criterion of existence the open system [32]. The relation (31) is a generalization of the negentropic principle of the theory of information, the Prigogine-Glensdorf principle [12], Shennon theorem [33] etc. Expression (32) is the condition for the existence of vacuum: $\delta S_g = 0$ is relative, $S_g = 0$ is absolute [12].

Thus in the theory of information-physical structures and in this section in terms of laws the most general unification was carried out.

Here are some thoughts on the relationship between physics and information theory. Consider a more detailed relationship $S_{\text{g}} = k{\cdot}x - \omega{\cdot}t$.

In fact, if $S_{\text{g}} > 0$, that is, $k{\cdot}x > \omega{\cdot}t$, then the structure changes, which means that over time the structural part of the measure increases, that is, it increases its entropy, action, etc. When $S_{\text{g}} < 0$, this means that the structural part of the measure of relatively intense (frequency-time) changes little, so physical processes pass at a different speed than information [12].

IV. POLYMETRIC ANALYSIS AND ECONOMETRICS

Polymetric analysis (PA) was created as alternative optimal concept to logical, formal and constructive conceptions of modern mathematics and more general theory of information [12] and is corresponded the basic notions of the universal theory of open systems. This concept is based on the idea of triple minimum: mathematical, methodological and concrete scientific [12].

However, one of the main tasks of polymetric analysis is the problem of simplicity-complexity that arises when creating or solving a particular problem or science.

In methodological sense, PA is the synthesis of Archimedes thesis: "Give me a fulcrum and I will move the world", and S. Beer idea about what complexity is a problem of century in cybernetics [12], in one system. And as cybernetics is a synthetic science, the problem should be transferred and for all of modern science. The universal simple value is unit symbol, but this symbol must be connected with calculation. Therefore it must be number. For the compositions of these symbols (numbers) in one system we must use system control and operations (mathematical operations or transformations). After this procedure we received the proper measure, which is corresponding system of knowledge and science.

Roughly speaking the basic peculiarity of polymetric analysis is the realization of Plato concepts of three types of numbers with computational point of view [12].

The basic questions, which must be resolve polymetric analysis are:

1) creation united system of optimal formalization the knowledge;

2) creation natural concept of foundations of mathematics, which is based on nature of mathematics,

3) creation universal theory of open systems.

Therefore the basic axiomatic of the polymetric analysis was selected in the next form [12].

Definition 1. **Mathematical construction** is called set all possible elements, operations and transformations for resolution corresponding problem. The basic functional elements of this construction are called constructive elements.

Definition 2. The mathematical constructive elements $N_{x_{ij}}$ are called **the functional parameters**

$$N_{x_{ij}} = x_i \cdot \bar{x}_j, \tag{33}$$

where $x_i, \bar{x}_j$ – the straight and opposite parameters, respectively; $\cdot$ – respective mathematical operation.

Definition 3. The mathematical constructive elements $N_{\varphi_{ij}}$ are called the **functional numbers**

$$N_{\varphi_{ij}} = \varphi_i \circ \bar{\varphi}_j. \tag{34}$$

Where $\varphi_i\left(x_1,\dots x_n,\bar{x}_1,\dots \bar{x}_m,\dots N_{x_{ij}},\dots\right)$, $\bar{\varphi}_j\left(x_1,\dots x_n,\bar{x}_1,\dots \bar{x}_m,\dots N_{x_{ij}},\dots\right)$ are the straight and opposite functions, respectively; $\circ$ – respective mathematical operation.

The theory of generalizing mathematical transformations is created for "work" on functional numbers [1, 34].

Definition 4. **Qualitative transformations** on functional numbers $N_{\varphi_{ij}}$ (straight A_i and opposite $\bar{A}_j$) are called the next transformations. The straight qualitative transformations are reduced the dimension $N_{\varphi_{ij}}$ on I units for straight parameters, and the opposite qualitative transformations are reduced the dimension $N_{\varphi_{ij}}$ on j units for opposite parameters.

Definition 5. **Quantitative** (**calculative**) **transformations** on functional numbers $N_{\varphi_{ij}}$ (straight O_k and opposite $\bar{O}_p$) are called the next transformations. The straight calculative transformations are reduced $N_{\varphi_{ij}}$ or corresponding mathematical constructive element on k units its measure. The opposite quantitative transformations are increased $N_{\varphi_{ij}}$ or corresponding mathematical constructive element on l units its measure, i.e.

$$O_k O_p N_{\varphi_{ij}} = N_{\varphi_{ij}} - k \oplus p. \tag{35}$$

Definition 6. **Left and right transformations** are called transformations which act on left or right part of functional number respectively.

Definition 7. The maximal possible number corresponding transformations is called **the rang of this transformation**

$$rang(A_i \bar{A}_j N_{\phi_{ij}}) = \max(i, j), \tag{36}$$

$$rang(O_k \bar{O}_p N_{\phi_{ij}}) = \max(k, p). \tag{37}$$

Remark 1. The indexes *i, j, k, p* are called **the steps of the corresponding transformations.**

For this case we have finite number of generalizing transformations. We have only 15 minimal types ob generalizing transformations [12, 13].

Basic element of PA is the generalizing mathematical elements or its various presentations – informative knots [12]. Generalizing mathematical element is the composition of functional numbers (generalizing quadratic forms, including complex numbers and functions) and generalizing mathematical transformations, which are acted on these functional numbers in whole or its elements [12]. Roughly speaking these elements are elements of functional matrixes.

This element ${}^{stqo}_{nmab}M_{ijkp}$ may be represented in next form

$${}^{stqo}_{nmab}M_{ijkp} = A_i \bar{A}_j O_k \bar{O}_p A^r_s \bar{A}^r_t O^r_q \bar{O}^r_o A^l_n \bar{A}^l_m O^l_a \bar{O}^l_b N_{\varphi_{ij}}. \tag{38}$$

Where $N_{\varphi_{ij}}$ – functional number; $O_k, O^r_q, O^l_a, \bar{O}_p, \bar{O}^r_o, \bar{O}^l_b$; $A_i, A^r_s, A^l_n, \bar{A}_j, \bar{A}^r_t, \bar{A}^l_m$ are quantitative and qualitative transformations, straight and opposite (inverse, with tilde), (*r*) – right and (*l*) – left.

Polyfunctional matrix, which is constructed on elements (38) is called **informative lattice.** For this case generalizing mathematical element was called knot of informative lattice [12]. Informative lattice is basic set of theory of informative calculations. This theory was constructed analogously to the analytical mechanics [12].

Basic elements of this theory are [12]:

1. **Informative computability** C is number of possible mathematical operations, which are required for the resolution of proper problem.

2. **Technical informative computability** $C_t = C\sum t_i$, where t_i – realization time of proper computation.

3. **Generalizing technical informative computability** $C_{t0} = k_{ac} C_t$, where k_{ac} – a coefficient of algorithmic complexity [12].

Basic principle of this theory is **the principle of optimal informative calculations** [12]: any algebraic, including constructive, informative problem has optimal resolution for minimum informative computability *C,* technical informative computability C_t or generalizing technical informative computability C_{to}.

The principle of optimal informative calculations is analogous to action and entropy (second law of thermodynamics) principles in physics. This fact is caused of formula (29), where S_g may be represented as dimensionalless system function of information. Roughly speaking it may be informative calculations too.

The principle of optimal informative calculation is more general than **negentropic principle the theory of the information** [31] and **Shennon theorem** [33]. This principle is law of the open systems or systems with variable hierarchy.

The negenthropic principle and Shennon theorem are the principles of systems with constant hierarchy.

Idea of this principle of optimal informative calculation may be explained on the basis de Broglie formula (29) (equivalence of quantity of ordered and disorder information) [12]. Therefore we can go from dimensional quantities (action and entropy) to undimensional quantity – number of proper quanta of information or after generalization to number of mathematical operations. Thus, theory of informative calculations may be represented as numerical generalization of classical theory of information and analytical mechanics according to computational point of view [12].

For classification the computations on informative lattices hybrid theory of systems was created [12]. This theory allow to analyze proper system with point of view of its complexity,

The basic principles of hybrid theory of systems are next: 1) **the criterion of reciprocity;** 2) **the criterion of simplicity**.

The criterion of reciprocity is the principle of the creation the corresponding mathematical constructive system (informative lattice). The criterion of simplicity is the principle the optimization of this creation.

The basic axiomatic of hybrid theory of systems is represented below.

Definition 8. The set of functional numbers and generalizing transformations together with principles reciprocity and simplicity (informative lattice) is called **the hybrid theory of systems** (in more narrow sense the criterion of the reciprocity and principle of optimal informative calculations) [12].

Criterion of the reciprocity for corresponding systems is signed the conservation in these systems the next categories:

1) the completeness;
2) the equilibrium;
3) the equality of the number epistemological equivalent known and unknown notions.

Criterion of the simplicity for corresponding systems is signed the conservation in these systems the next categories:

1) the completeness;
2) the equilibrium;
3) the principle of the optimal calculative transformations.

Criterion of reciprocity is the principle of creation of proper informative lattice. Basic elements of principle reciprocity are various nuances of completeness. Criterion of the simplicity is the principle of the optimality of this creation.

For more full formalization the all famous regions of knowledge and science the **parameter of connectedness σ_t** was introduced [12]. This parameter is meant the number of different bounds the one element of mathematical construction with other elements of this construction. For example, in classic mathematics $\sigma_t = 1$, in linguistics and semiotics $\sigma_t > 1$. The parameter of connectedness is the basic element for synthesis in one system of formalization the all famous regions of knowledge and science. It is one of the basic elements for creation the theory of functional logical automata too.

At help the criteria of reciprocity and simplicity and parameter of connectedness the basic famous parts of knowledge and science may be represent as next 10 types of hybrid systems [12, 13]:

1. The system with conservation all positions the criteria of reciprocity and simplicity for all elements of mathematical construction ($N_{\varphi_{ij}}$ and transformations) is called the *simple system.*
2. The system with conservation the criterion of simplicity only for $N_{\varphi_{ij}}$ is called the *parametric simple system.*

Remark. Further in this classification reminder of criteria of reciprocity and simplicity is absented. It means that these criteria for next types of hybrid systems are true.

3. The system with conservation the criterion of simplicity only for general mathematical transformations is called *functional simple system.*
4. The system with nonconservation the principle of optimal informative calculation and with $\sigma_t = 1$ is called the *semisimple system.*
5. The system with nonconservation the principle of optimal informative calculation only for $N_{\varphi_{ij}}$ and with $\sigma_t = 1$ is called the *parametric semisimple system.*
6. The system with nonconservation the principle of optimal informative calculation only for general mathematical transformations and with $\sigma_t = 1$ is called the *functional semisimple system.*
7. The system with nonconservation the principle of optimal informative calculation and with $\sigma_t \neq 1$ is called *complicated system.*
8. The system with nonconservation the principle of optimal informative calculation only for $N_{\varphi_{ij}}$ is called *parametric complicated system.*
9. The system with nonconservation the principle of optimal informative calculation only for general mathematical transformations and with $\sigma_t \neq 1$ is called *functional complicated system*.
10. The system with nonconservation the criteriums of reciprocity and simplicity and with $\sigma_t \neq 1$ is called *absolute complicated system*.

With taking into account 15 basic types of generalized mathematical transformations we have 150 types of hybrid systems; practically 150 types of the formalization and modeling of knowledge and science [12].

Only first six types of hybrid systems may be considered as mathematical, last four types are not mathematically in classical sense. Therefore HTS may be describing all possible system of knowledge. Problem of verbal and nonverbal systems of knowledge is controlled with help of types the mathematical transformations and parameter connectedness [12].

Polymetric anaslysis may be used for the resolution many problems of modern science in whole and with using theories. These problems are included in its structure.

So, HTS may be used for the classification and creation old and new chapters of all science, including computing science.

HTS may be used for the represented of evolution of systems in two directions: 1) from simple system to complex system (example, from classic to quantum mechanics) and 2) conversely, from complex system to simple system (example, from formal logic to mathematical logic) [12].

Hybrid theory of systems is open theory. Parameters of openness are number of generalizing mathematical transformations and parameter of connectedness. Thereby we have finite number of types of systems, but number of systems may be infinite. Hybrid theory of systems allows considering verbal and nonverbal knowledge with one point of view [12]. Therefore this theory may be used for the resolutions various system problems of modern econometrics, including micro and macroeconomics.

V. CONCLUSIONS

1. Short historical analysis of development the econometrics is represented.
2. Necessary of creation more universal system, which is based on the theory of open system is analyzed.
3. Basic laws of equilibrium econometrics and its bond with thermodynamics are discussed.
4. An expansion of basic laws of econometrics with help uncertainty principle, thermodynamics of point (de Broglie formula) and theory of information is observed.
5. Main concept of polymetric analysis and hybrid theory of systems as universal theories of synthesis of knowledge and science are represented.
6. Possible applications of polymetric analysis and hybrid theory of systems are analyzed too.

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