Static and dynamic models in economics

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Abstract. In this article, the authors consider the impact of information and advertising on consumer behavior and the process of producing differentiation formation. Advertising, television, radio, magazines and direct mail as major constraints of mass media may act as sources of information. Economic modernization is aimed at development of acceleration of the knowledge intensive industries, which contribute to Russia’s position in terms of the world economy; the recovering process of the Russian economic manufacturing base; development of import substitution industries and limited participation in international labor specialization.

1. Introduction
In static models, the time factor is not explicitly taken into account. However, such models are best adapted for the solution of certain tasks. For example, in order to conduct a statics analysis, it is necessary to lay the foundation for the dynamic analysis. For carrying out the further analysis of economic categories of demand, supply and balance between them, it is necessary to differentiate the concepts of statics and dynamics essentially.

In various areas of science, the statics is defined differently. For example, the statics in mechanics is meant as the certain section studying laws of balance of bodies under the influence of forces applied to them. Obviously, such interpretation of a statics concept is also applicable in the studying of balance between supply and demand.

Moreover, according to H. Leibenstein, there are a huge number of statics definitions and, probably, it causes some confusion in this respect. Therefore, it is impossible to give an exact definition of statics. Everything that can be done is to choose a definition which will not contradict the research purposes and at the same time will not contradict standard definitions. As the modern world is a dynamic one, the majority of statics definitions will
state such situation which contradicts daily experience. But it is inevitable. The only way is to adhere to internal sequence, and not to stick to the concept of "realism".

In that case, this task is reduced to definition of a static state. A static state is such state to which the principles of statics are applicable. It is usually supposed that statics is something that exists ("timeless"); stat originates from the Greek statos — standing, motionless, the part of the word indicating a state invariance, constancy of something). It is not absolutely right.

Static state is not the state of a “timeless” nature, and the static economy is not the “timeless” economy, but it will be an economy in which there is no "temporary order". Thus, static is the state in which the order of events does not matter. Therefore, let us abstract from temporary sequence of events. This definition is similar, but at higher level of generalization, with Hicks's definition: "The statics is that part of the economic theory where one does not need to worry about date".

For internal coherence, it is also necessary to assume that such period in which the income and expenses of the buyer are synchronized in time is considered. Also, it is established that this statement is true for all buyers. In other words, the authors assume that in every period, income is formed, and there are expenses of the buyer.

Thus, expenses of one period do not coincide with expenses in the following. It means that only one price can exist during any single period and that this price can change only from period to period. Therefore, the misbalance can be aligned only within two or more periods.

2. Method

Static models possess property of zero lags. The last means that the value of the output parameter of a static model of t represents at any moment a certain function of value of its output parameter in the same time point of t and does not depend on values of input parameter to t time point. Static models are set in the form of one-dimensional and multidimensional algebraic functions.

The models which are directly considering time factor are usually called dynamic. In such models all variables of economic processes and systems are functions of time. Examples of dynamic models are equilibrium processes by Walras and the interaction of supply and demand by Marshall. Economic systems possess property of a lag effect. This property of system is characterized by the speed of change of its output parameters in response to changes of its input parameters and parameters of its functioning, average time of receiving a result when modifying functioning parameters.

Linear and nonlinear models.

A huge variety of the linear and nonlinear models and systems used in economic science are known nowadays.

The system is called linear, if at any numbers \( N, c_1, c_2, \ldots, c_N \) and at any functions \( f_1(t), f_2(t), \ldots, f_N(t) \):

\[
H \left\{ \sum_{n=1}^{N} c_n f_n(t) \right\} = \sum_{n=1}^{N} c_n H f_n(t)
\]
This general property of linear systems usually is called the principle of superposition. Therefore linear systems can be defined as such systems for which the principle of superposition is fair.

When studying models of supply and demand in multidimensional space of factors, it is necessary to pay special attention to a problem of applicability of the linear and additive equations or functions. Concepts of linearity and additivity are often identified though they have essential distinctions [269]. Function \( y = f(x_1, x_2, \ldots, x_n) \) is linear on all independent variables only in case when the derivative of function \( \frac{dy}{dx_i} \) does not include variable \( x_i \), i.e. when \( \frac{d}{dx_i} \left( \frac{dy}{dx_i} \right) = 0 \). And they say that function \( y = f(x_1, x_2, \ldots, x_n) \) is additive on \( x_i \) only in case when \( \frac{dy}{dx_i} \) does not include \( x_j (j \neq i) \), i.e. when \( \frac{d}{dx_j} \left( \frac{dy}{dx_i} \right) \frac{d}{dx_i} \left( \frac{dy}{dx_i} \right) = 0 \).

The effect of this change on each independent variable does not depend on the level of other variable.

The generalized form of the additive multidimensional model of demand is represented as:

\[
Q = \sum_{i=1}^{f} \alpha_i Q(x_i)
\]

where \( \alpha_i \) – coefficients or weight, represent relative importance of a factor of demand (or supply) \( x_i \).

Along with additive multidimensional models, multiplicative multidimensional models can be used as well. Because of inevitable difficulties in complying with the conditions of use of multiplicative models, most of researchers resort to use of additive models.

In any multidimensional task, the first step should be defining factors for which the study of demand and supply is carried out. It is important to show the direction of influence of each factor on the studied market phenomenon. Some factors can lead to positive consequences while others lead to negative ones. The circumstances arising when studying the market phenomena are the interdependences between factors.

Additivity is a suitable determination of this feature in view of the fact that the joint effect of change on all considered independent variables can be gained by addition of separately calculated effects of changes on each of them.
Non-additivity of the system is basic irreducibility of properties of the system to the sum of properties of components, composing it, and non-derivability of properties of the complete system from properties of components. Each component can be considered only in its connection with other system components. On the other hand, functioning of system cannot be reduced to functioning of its separate components. Cumulative functioning of the diverse interconnected components qualitatively generates new functional properties of the whole, not reducing to the sum of properties of its components.

The system is called nonlinear if the principle of superposition for it is not carried out, i.e. \( f(x_1 + x_2) \neq f(x_1) + f(x_2) \).

Operator H of the nonlinear system is always non-linear. The concept nonlinearity is often used for designating the processes described by the nonlinear equations. In mathematical sense, equations that contain values in degrees greater than one may have multiple qualitatively different solutions.

More generally, the notion of nonlinearity is used to specify multiple variations, alternatives and irreversibility possible ways of complex economic systems evolution.

For nonlinear systems, nonlinearity and non-additivity are characteristic relations between its variables. The analysis of a set of works on the economic theory shows that in recent years, a refusal of a linearity hypothesis of economic relations has been observed. If linearity of relations is refused, it is logical to make the same, concerning a continuity condition that leads to situations, which can be qualified as "chaos" or "catastrophe".

Consideration of possibility of a chaotic situation leads to a new problem: a problem of the ratio between stochastic nature of fluctuations of factors, on the one hand, and relation between these fluctuations and a long-term tendency, on the other hand.

Statistical methods which were used for the analysis of data, allowed establishing stochastic character of some variables. Existence of long-term tendencies leads to minimization of casual impacts effects on balance ("walking at random" is a random walk) or, at least, testifies that their effects are limited in time.

In fact, the legitimacy of the use of the term "hysteresis" (nonlinear model) is doubtful, since its application would require very strong assumptions, in particular, the negation of any of autonomy and functioning of the economic system.

Nonlinear economic and, in particular, market processes are so difficult and various that it is hardly possible to give rather simple and universal classification of all nonlinear models described by nonlinear operators. However, it should be noted that in that specific case methods of linear systems can be extended to nonlinear systems and by that to bring methodological uniformity to research of nonlinear systems. Such methodological uniformity is reached when the mathematical model is under construction in the form of a number of Volterra by means of which the wide class of nonlinear stochastic market processes with desirable degree of accuracy can be described.

The methodology of synthesis of nonlinear models of supply and demand in space of many factors is considered by the authors in the subsequent chapters of this monograph.

So, from the considered works, it is possible to draw a conclusion on the need of revision of regularity and accident.
Random effects can significantly change the trend and affect the trajectory of demand and supply. However, this is not what happens all the time. More often random effects cause oscillatory process in demand or supply which quickly fades. From such positions it is possible to recognize methodological validity of return to accident, thus, assuming the existence of unpredictability, but thus without plunging into the abyss of an indeterminism. There are many kinds of determinism. But they all correspond to certain structures and institutions, and therefore, the particular systems that are themselves subject to changes provoked by deliberate or spontaneous actions.

Here is the authors’ approach to the following fundamental conclusion. The problem of uncertainty is a watershed between the classical economic theory, both old and new, and a new approach. The essence of a problem consists in whether the economy set of the same subjects is uniform streams and relations, or, on the contrary, it is characterized by qualitative and various heterogeneity. In the first case, balance is understood as the fixed point (the determined approach); in the second, it is considered as a locally steady, temporary and casual state (stochastic approach). All this is defined by the level of the accounting of real factors of supply and demand.

Sign models. In the economic theory, sign models are widely used. These include text, graphical, mathematical and computer models.

Text models consist of words and sentences of natural or artificial language. They are a basis of descriptive modeling. Text models possess the big explaining ability. However, they occupy large volume of a data carrier, are not formalized mathematically and their operating even on modern computers is complicated. Graphic models have more presentation and the explaining ability.

When creating the graph on the abscissa axis, there are these factors, and value of the result is on the ordinate axis. The visual analysis of the graph allows making a hypothesis of existence of positive or negative relation between the chosen microeconomic indicators, i.e. factorial and productive signs. For example, the curves of supply and demand from a price factor, introduced into political economy by A. Marshall, became traditional.

Graphic models at the same time have shortcomings. Easy visibility of interrelations between variables quickly disappears with increasing in the number of variables.

Easily visible and readable graphs are two-dimensional, while three-dimensional graphs amenable to review and to reading are not so easy, and multidimensional graphs with more than three variables do not exist at all. However, they can be represented by a sequence of the three-dimensional graphs, shifted in space relatively each other characterizing change of influence of the fourth variable, etc.

Besides, multidimensional graphs can be projected, i.e. are displayed on the separate planes of two variables that were shown in G. S. Svetunkov's work.

Models of economic objects, in particular models of supply and demand in the form of mathematical formulas, interrelations between many variables are well describe, adapted for use on computers and therefore are powerful tools of modeling of difficult economic processes and phenomena. The computer method of modeling in economy has a particular advantage in a case when the object is described by different difficult systems of the equations that often takes place when modeling various processes in a transitional
economy. Thus, numerical and graphic methods are the unique approach to construction and the analysis of functioning of economic models.

3. Conclusions
In the theory, the elements of the market mechanism are insufficient, explanatory, predictive, and descriptive features of the theory of supply and demand by A. Marshall. In terms of heterogeneity and non-stationarity of economic objects and subjects, they are reflected in the experience of the socio-economic transformation of Russia.

As a result of the analysis, basic principles of research of the competitive markets were formulated, to which concepts of market determinism and indeterminism belong.

It was established that the majority of the directions of research in the field of classical theory of supply and demand developed in relation to economic processes, characteristic for a set of the same consumers and producers, uniform commodity streams and relations.

However, in connection with internal social and economic transformations and need of adaptation to shifts in the world economy, the Russian economy was non-uniform. Understanding of the economy, which is non-uniform, became one of the priority directions of modern research. It substantially belongs also to the neoclassical theory of market balance based on a condition of minimization of excess demand. It does not consider many realities and is a special case of the possible non-uniform market behavior of buyers and producers described by multidimensional models of supply and demand.

A new interpretation of the assumption “with other things being equal” acting as one of the attributes of the classical theory of supply and demand of A. Marshall, in case of heterogeneity of parameters of goods, behavior of consumers-buyers and producers-sellers, is offered.

Classification of the markets on the basis of uniformity (uniform, transitional from uniform to non-uniform and non-uniform markets) and by the number of sellers and buyers is carried out (one-dimensional, transitional and multidimensional).

Definitions of one-dimensional, two-type transitional and multidimensional markets are introduced. In the multidimensional markets, multidimensional connection is established between a great number of sellers and a great number of buyers. Depending on the number of sellers and buyers and their ratio, there is either a duopoly or a duopsony, either an oligopoly or an oligopsony, or a polipoly, which is confirmation of the philosophical law of transition of quantitative ratios to quality in the sphere of economy.

References
[1] Anderson E W, Fornell C, Lehmann D R and Sullivan M W 1993. The antecedents and consequences of customer satisfaction for firms *Marketing Science* 12 (2) 125-143
[2] Bagautdinova N G, Safiullin L N, Safiullin N Z and Gafurov I R 2012 Influence of quality of the goods on satisfactions of consumers *Journal on Business Review* 2 (2) 225-232
[3] Melnik A N and Mustafina O N 2013 The Organization of Russian Power Market in Modern Conditions *Middle-East Journal of Scientific Research (Socio-Economic*
Sciences and Humanities) 13 91-94
[4] Bischoff I and Meckl J 2008 Endowment effect theory, public goods and welfare Journal of Socio-Economics 37 (5) 1768-1774
[5] Bolton R N and Lemon K N 1999 A dynamic model of customers’ usage of services: Usage as an antecedent and consequence of satisfaction Journal of Marketing Research 36 (2) 171-186
[6] Brown G and Raymond C 2007 The relationship between place attachment and landscape values: Toward mapping place attachment Applied Geography 27 (2) 89-111
[7] Novenkova A Z, Kalenskaya N V and Gafurov I R 2013 Marketing of Educational Services: Research on Service Providers Satisfaction Procedia Economic and finance 5 667-676
[8] Power M 2004 Counting, control and calculation: Reflections on measuring and management Human Relations 57 (6) 765-783
[9] Jagpal S and Spiegel M 2011 Free samples, profits, and welfare: The effect of market structures and behavioral modes Journal of Business Research 64 (2) 213-219
[10] Laffont J J 1989 The Economics of Uncertainty and Information (The MIT Press, Cambridge, MA 343)