

## THE PROBLEM OF TRUTH IN ECONOMICS AND MATHEMATICS

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### **-Abstract-**

Many economists – scientists, academics and experts in economic policy – express a concern about the fact that today mathematical methods play the increasing role in the study of the complicated economic reality. Mathematics is a highly abstract science, and economics deals with changeable reality, policy, living people and social processes. So, there is the question, whether mathematical abstractness turns economics into the area of a peculiar intellectual game, away from reality? To answer this question, we need to research the concept of truth in economic science and mathematics.

In the modern science, the concept of truth is the one of the most ambiguous issues. Philosophical understanding of this concept has a long history, connected with clarification of the essence of such categories as scientific rationality and its types, scientific status of the studied discipline, the essence of the notion of truth in different types of science.

Philosophical and methodological examination of the concept of truth in economics and mathematics allows to understand that the complexity of each science has its specifics. Understanding of truth in economics and mathematics depends on understanding of the subject, philosophical and methodological bases of each science, and it is also connected with the question of realness of economic models and mathematical objects.

**Key Words:** Philosophy of Economics, Methodology of Economics, Mathematics, Truth

**JEL Classification:** B41, C02, C18

### **1. INTRODUCTION**

In our opinion, the problem of truth in economics and mathematics can be considered in a foreshortening of three major points: subject of each science, its

philosophical and methodological bases, interrelation of economic models and mathematical objects with reality.

We aim to define specifics and common features of the statement of the problem of truth in economics and mathematics and also to look how features in understanding of truth effect interaction of these sciences. For realization of this purpose we have formulated the following tasks: 1) to define philosophical sense of a problem of truth; 2) to analyze a problem of definition of a subject in economic science and mathematics; 3) to present the philosophical and methodological bases of economic science and mathematics; 4) to define specifics of a problem of correspondence of economic models and mathematical objects to reality.

## **2. TRUTH IN PHILOSOPHY AND SCIENCE**

### **2.1. The notion of truth**

The problem of truth is a cross-disciplinary subject, but its roots have philosophic nature. Our tasks don't include the insight into history of understanding of truth in philosophy and science, so we proceed from the present understanding of the notion of truth.

Today the question of truth is, first of all, a question of the nature of truth, of what are conditions and reasons for something to be true. Modern philosophical dictionaries and encyclopedias define the notion of truth as follows:

- according to The Cambridge Dictionary of Philosophy truth is “the quality of those propositions that accord with reality, specifying what is in fact the case”. (Truth, 1999: 929);
- in “The New Philosophical Encyclopedia”, published by the Institute of philosophy of the Russian Academy of Sciences truth is "the category of philosophy and culture designating an ideal of knowledge and a way of its achievement (justification)" (Kasavin, 2010).

In our opinion, the second definition better reflects modern philosophical and scientific understanding of truth as epistemological (and not only) construct. Since the philosophical concept of truth is wider, it is descriptive and assumes interpretation. In philosophy, truth belongs not only to rational, but also to esthetic and moral knowledge, and to our actions.

Scientific understanding of truth is more instrumental and assumes

- existence of the accurate criterion of truth having ontological character, that is correlating knowledge to a certain reality;
- binary assessment of truth (the statement either is true, or it is false);
- distinction of the theoretical and empirical truth;
- the discourse of truth is carried out within distinction (and opposition) of judgments and notion (Kasavin, 2010).

For the exception of three most known theories of truth – correspondence, coherence and pragmatists, see Stanford (2016) – there are many others. One of them is the *normative theory of truth*. According to it, historical and cultural conditions have special value for determination of the validity of our knowledge; these conditions form a certain tradition of knowledge and discourse of truth. It is remarkable that in the process of estimating our knowledge by criterion of validity, such characteristics like checked, correct, effective (i.e. not connected with truth directly) are usually attributed to knowledge. It is clear, that the normative theory of truth is selective in relation to the fact that can (or can't) be true in these historical and cultural conditions. At the same time, this theory represents a certain average view of what the truth is. The normative theory of truth is a product of the postmodern philosophy recognizing the plural nature of truth.

Consequently, there are main characteristics of modern understanding of truth:

- the nature of truth discourse from ontological became epistemological, and now it is built in a problematic view of the justification of knowledge; hence the attention to knowledge methodology;
- today truth is entered in specific historical and cultural conditions of knowledge, and so the increased popularity of history of ideas and "archaeological" (a la M. Foucault) knowledge research;
- results of many research within the social humanities are checked not for truth, but for compliance to needs of society and applicability in certain sphere. A striking example is the activity of experts in grant organizations, and generally the formation of grants under scientific projects;
- development of understanding the subject-object relations in the process of knowledge led to the fact that truth began to be understood as a difficult, complex concept which includes both subject and object of knowledge, and the cognitive process itself;

- at last, the network organization of knowledge and multiplicity of truth appear the base for interdisciplinary research and adoption of P. Feyerabend's approach – methodological pluralism (Feyerabend, 2002).

### **3. TRUTH IN ECONOMICS AND MATHEMATICS**

As it can be seen in modern publications, indexed in Web of Science, EBSCO, Springe, Russian eLibrary and other informational bases (417 search results in total), in economics, the majority of the found works having the word "truth" in the title concerns not a philosophical, theoretical problem of truth, but private economic problems of justice (righteousness). In mathematics, the most part of works are devoted to mathematical theories of truth. Therefore, the problem of truth in economics and mathematics oversteps the bounds of these sciences and it is a subject of philosophy and methodology of economics or mathematics<sup>1</sup>.

#### **3.1. Subject of economics and mathematics**

Objectively – i.e. through an object of research (world, human beings and their relation) – all sciences are interconnected. However, their subject spheres are various, although they are crossed. To define a subject of science means to specify its place among other sciences<sup>2</sup>. For economic science, it is more difficult to make it, than for mathematics. In modern classification of sciences, economics belongs to social sciences, but it is more correct to tell it is on the border of natural sciences and the social humanities.

As for mathematics, there is the discussion about whether it is an independent science, or it belongs to natural sciences, or maybe represents the universal language of science in general. However, the development of economic science also raises a question whether economics can be the universal language of social sciences, whether it is a science at all (or it's only "a box with tools", a set of models), or, maybe, it is similar to physics on the accuracy and objectivity of its results. Each of these questions demands separate research and it can't be a subject of this work.

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<sup>1</sup> Professor of mathematics K. Kunen notes that "the justification for the axioms... is part of the motivation, or physics, or philosophy, not part of the mathematics. The mathematics itself consists of logical deductions from the axioms» (Kunen, 2007: 5).

<sup>2</sup> J. Schumpeter, on the contrary, read that it is better to distinguish sciences in a type of created theories. So, the natural sciences create the explaining theories, and the economics offers different interesting points of view on the problems and is, in effect, tool kit of historical, statistical and theoretical research (Schumpeter, 2006).

• **The subject of economic science.** In this work, speaking about the subject of economic science, we will mean the neoclassical economic theory as it takes the leading position in the mainstream economic science. The conventional definition of the subject of economic science is given by L. Robbins: economics “studies human behavior as a relationship between ends and scarce means which have alternative uses” (Robbins, 1932: 15). The key moment in any definition of a subject of economic science is the specification of what, actually, is *economic* and how it differs from *natural* or *social*. Robbins connected *economic* with rare resources, some economists criticized by him – with material requirements, today *economic* expresses the monetary relations, and calculation of benefits and expenses. As the concept of rare resources is itself rather wide, Robbins's definition doesn't allow to accurately estimate the borders of *economic*.

The interpenetration of social and economic has an objective nature as economic activity is a type of social activity. Social can be defined as a set of properties and features of the relations between elements in a certain society which are shown in interaction of individuals and their groups. Economic is a type of the social relations concerning production, distribution, consumption and reproduction of the benefits – goods, services, and (in modern economy) impressions. It is important to note that in L. Robbins's definition told nothing about the purposes of economic activity: the scientist considered that the variety of the purposes is outside the interest of economists. Such approach has given the chance to understand economic activity very widely and to consider the economic sphere defining in relation to all of social space.

Economic science's claims for natural-science objectivity of process and results of economic knowledge also have their reasons. First, historically economic science was guided by the ideal of scientific rationality created during the time of blossoming of natural sciences, before the discussion of distinctions of natural sciences and humanities held in Neo-Kantianism. Secondly, economic science (economics) studies an average individual, mass processes which are subject to accounting. At last, thirdly, economics deals with material resources. The need of application of mathematics for economics connects it with natural sciences, but in this regard, we quite often lose understanding of what specifically economic is.

• **The subject of mathematics.** Mathematics subject nowadays is defined as the system of the abstract idealized objects expressed in a sign form. We can identify two types of views of the mathematics nature: *pragmatical approach* considers mathematics a natural science studying regularities of a material world, and *ideal approach* considers mathematics as an independent science which isn't connected

with a material world directly (Janov, 2006). Today pragmatical approach prevails. One more, the *instrumental* point of view on the nature of mathematics represents it as the language of science. This approach has arisen within physics. No doubt mathematics can be used as a language of science, but propositions of this language demand substantial interpretation and can't be formulated without having real objects in our experience before anything could be saying.

As we see, definition of a subject of economic science and mathematics has discursive character, in economic science more, than in mathematics. The main difficulties in definition of a subject of these sciences connected with the clarification of their scientific title, i.e. the place among other sciences. In the field of philosophical and methodological bases of science these problems are highlighted in a more particular way.

### **3.2.Philosophical and methodological basis of economics and mathematics**

In our view, the philosophical bases of science are a complex of ideas making the foundation of a scientific picture of the world and the foundation of a disciplinary ontology. The methodological bases of science indicate the principles of statement of scientific problems and the organization of process of their solution.

The model of homo economicus is a part of "rigid kernel" of the neoclassical economic theory. Its main prerequisites are as follows:

- principle of methodological individualism;
- principle of economic rationality;
- principle of maximizing utility;
- equilibrium theory;
- egoism.

The model of man in neoclassical economics sets parameters of the one of two competing economic ontologies – behavioral and the other is the institutional ontology (Ananyin, 2013). The behavioral ontology represents a complex of theories describing the world in categories of choice, limited resources and boundless needs, egoistic and rational behavior, maximizing utility, market balance, etc.

The philosophical bases of behavioral ontology should be looked for in the field of the ideas of human nature which were developed in the 17-18th centuries in the contributions of R. Descartes, D. Yum and I. Bentam, and positivists of the 19th century. The Cartesian rationalism has caused understanding of a person as the rational individual resisting to the material world. A debate about a ratio of personal

and public interest has led to the formation of the principle of utility (Sedlacek, 2011; Laval, 2010: 21). Bentam`s utilitarianism assumed a possibility of quantitative comparison of pleasure and suffering, and what it is possible to call egoism of individual needs (a person seeks to satisfy first of all his very interests). The Enlightenment`s belief in progress on the basis of rational knowledge of the world and development of science was wonderfully combined with the taken from physics idea of balance as a perfect condition of society. The positivism has called into question a possibility of scientific knowledge of the reasons of the phenomena occurring in nature and society. It also has supported the initially peculiar to economic science orientation to a natural-science ideal of rationality. Besides, the economic ontology is caused by certain facts, identification and description of which create new economic reality (Potts, 2010: 283).

The methodological bases of economics in many respects follow from the aforesaid. Mathematization of economic methodology is a naturally occurring result of the certain tendencies developing in knowledge of social reality.

The other important question is the question of what type of reasonings lies in the basis of economics and mathematics: deductive or inductive? Both in economics and mathematics there are initial assumptions – the axioms accepted without proof. On the basis of these axioms one can form theories and theorems. One of the essential lines both of economics and mathematics is an abstraction as property of human thinking. But if an economic abstraction is a process of derivation from certain characteristics of an object, then mathematical abstractions are a result of idealization, derivation not from properties of real objects, but from their qualitative, substantial party. Thus, the mathematics can't be a learning tool of the developing objects as it can't replace substantial reflection about the real phenomena.

Historically, economics develops towards the emergence of the increasing variety of approaches, concepts, theories and schools. However, the dominating approach is the neoclassical economic theory, which is trying to learn the developing and substantial social phenomena by means of mathematical methods. Economization of social sciences and social life in this context means their growing formalization and unification. At the same time, paradoxically, neoclassical approach is as positive as also normative because formalization in economics is based not on laws of mathematical knowledge, but on a tendency to unification of thinking. As the Finnish philosopher and the methodologist of economics U. Mäki (2009) noted, the instrumental type of unification is peculiar to neoclassical economics: it is when

theories don't correspond to logic of reality, but show logic of a certain type of thinking, in our case – economic thinking.

In this regard, the question of compliance of economic models and mathematical objects to reality seems especially interesting.

### **3.3.Economics, mathematics and reality**

The problem of the attitude of results of our knowledge towards cognizable reality arose in ancient philosophy. One of aspects of this problem is the question of how the specific objects formed within certain sciences belong to reality. For economics, such objects are economic models, for mathematics – abstract objects.

A model in natural and social sciences represents the simplified image of a certain cut of reality. A model allows to put outside braces those properties and lines of reality which, as it is represented to the researcher, don't matter for his work. Modeling is the system of the principles of creation of such simplified image. In mathematics modeling is defined a little differently – as we wrote above, it is rather an idealization model which cornerstone is a derivation from the substantial part of the real phenomena.

In this sense the modeling process algorithm, known in social sciences, is hardly applicable to mathematics. It contains the following elements: statement of a research objective and definition of its subject; selection of essential properties of the studied reality; creation of model; check of model; necessary specifications. Therefore, the problem of compliance of economic models and mathematical abstractions to reality needs to be considered differently for each science.

• **Economic models and reality.** In modern scientific economic literature, there is an extensive criticism of economic models concerning the realness of their prerequisites. In this context D. Rodrik (2015) gives an interesting approach to the analysis of economic models. Defining a model as “simplification designed to show how specific mechanisms work by isolating them from other, confounding effects” (Rodrik, 2015: 12), he notes that not all the prerequisites of economic model have to be realistic, but its crucial prerequisites surely have to. A prerequisite is crucial if “its modification in an arguably more realistic direction would produce a substantive difference in the conclusion produced by the model” (Rodrik, 2015: 17).

For us the most interesting is the model of homo economicus reflecting the main methodological assumptions of the neoclassical economic theory. In application to this model there can be two questions: 1) is there somewhere in reality a human being like economics understands him? 2) whether the conclusions received from

model of the homo economicus tell us about how an economic agent will really behave?

The first question sends us to the philosophical bases of economics. Not half of economists agree with such formulation of a problem of realness of the homo economicus model, because, as Russian methodologist of economics, V. Avtonomov (1998: 8) notes, neoclassical economics considers the homo economicus only as a tool of the analysis of economic reality. On the other hand, the model of homo economicus obviously relies on certain notions of the person (Laval, 2010). To this extent, it makes sense to address the first question not to economists, but to philosophers and methodologists of economics. The second question focuses just on crucial assumptions of this model and therefore it is within the subject field of economic science.

Now, thanks to the development of cross-disciplinary research at the confluence of economics and other sciences, the main assumptions of the homo economicus model are modified. So, the principle of full rationality is replaced with the principle of limited rationality, the principle of maximizing utility – on the principle of achievement of satisfactory result. These prerequisites became more realistic that has allowed to specify conclusions from the homo economicus model. However, the principles of methodological individualism and economic rationality haven't been modified. In our opinion, they exactly are the crucial assumptions of the homo economicus model, as their modification, most likely, will change "rigid kernel" of neoclassical economics, so it will lead to paradigm changes in economic science.

• **Mathematical objects and reality.** Discussion about the status of mathematical objects not so heating, as in case of economics. Now scientists have come to the conclusion that it isn't necessary to look for compliances of mathematical objects to reality because these objects are the product of an abstraction of higher level than in natural sciences – an idealization product. On the other hand, the mathematics certainly relies on experience, and is used for transformation of reality; therefore, its objects aren't a fruit of the imagination which is torn off from reality. These representations developed within intuitionist and formalist programs of grounding of mathematics.

But the description of reality by the means of formal language can be only mediate and incomplete as bounds of formalization are limited. To get closer to reality, mathematical theories have to be exact and consistent, but after all the reality is broader than formal and logical rules, it develops, but mathematics deals rather with structure, than with dynamics of development. Therefore, obviously, the solution

of a question of realness of mathematical objects and theories connected with specifics of real processes which we analyze with mathematical methods.

These specifics need to be considered both at a stage of initial formalization when we set parameters and the main variables of the analysis, and at a stage of interpretation of results when we make the translation from the formal (that is artificial) language of formulas into disciplinary (so, in many respects natural) language. But, of course, the problem of realness of mathematical objects is wider than a problem of the translation from a natural language into the artificial and back – the translation needs to be adjusted, "adding" the specific maintenance of the researched phenomenon.

All questions considered by us concern the problem of truth in economics and mathematics, and now it is necessary to draw certain conclusions.

#### **4. INTERRELATION BETWEEN ECONOMICS AND MATHEMATICS, AND THE PROBLEM OF TRUTH**

In mathematics, the problem of truth has taken the form of the proof of consistency of mathematical theorems. In general, we know truth several meanings of mathematic truth<sup>3</sup>; Russian philosopher of mathematics V. Perminov (2001) writes about the formal, semantic, empirical, ontologic and factual truth<sup>4</sup>. He especially marks out two last interpretations of truth, and we believe, in economics they are also relevant. The *ontologic treatment* connects the initial principles of a theory with the certain picture of the world expressed in categories; the *factual treatment* shows the attitude of the initial principles of a theory to the system of the facts (or theorems) representing a genetic basis of this theory (Perminov, 2001: 150-151).

The mathematical proof has the logical, deductive nature. As the logic is a part of mathematics, mathematics, concerning the proof of the validity of the theorems, is a "closed" science. Economics, on the contrary, is opened in a space of social experience which certifies conclusions of economic science about behavior of economic agents.

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<sup>3</sup> Solid historical review of approaches in understanding of mathematical truth (from I. Kant to the debates of realists and anti-realists) can be found in Dales, Oliveri (1998).

<sup>4</sup> P. Benacerraf (1973) suggests an alternative approach, that the notion of truth should be unique both for empirical and for more theoretical knowledge, because those types of knowledge are interrelate and interdependent (Benacerraf, 1973: 662).

Today the problem of truth in mathematics connected with a problem of justification of this science. Besides the existing classical programs of such a justification – intuitionism, logicism, formalism – there is the ontologic program. The concept of the ontologic truth, "establishing connection of the initial mathematical principles with categorial structure of thinking" is the cornerstone of this program (Perminov, 2001: 148). In our opinion, this program is submitted as the most adequate because it allows to look more deeply at the problem of truth in mathematics, without identifying validity with consistency, being guided by features of mathematical knowledge and mathematical objects. In economics, the similar program can be realized within philosophy of economics with a support on a concept of economic ontology.

There are also two approaches of understanding truth in mathematics: one, pragmatical, connects the validity of mathematical theorems with "language of the facts" that puts such understanding of truth into dependence on the available system of categories, acquired scientific base (including developed mechanism of experiment) and language designs (Janov, 2006). So, it is the relative understanding of truth in mathematics. Idealistic approach considers an entity of the mathematical truth more adequate, because a theorem once the proved remained either. Thus, the mathematical truth (by its formal nature) is absolute, and truth in other sciences, including economics, is relative. P. Koellner (2009) believes the question of truth during the evolvement of mathematics was elided from the space of its problems because mathematical axioms only show us logical opportunities of system. In some sense, we can apply this approach also to economics, in particular, to the economic imperialism which actually only shows logical opportunities of economic approach in social sciences. But, as a disciple of Cambridge Social Ontology Group, S. Pratten (2004) writes, mathematical formalism in economics doesn't consider specifics of social objects, because neoclassical economics finds them static, atomic and closed while they are constantly change, interact and form qualitatively new realities, other than what gives individual existence (Pratten,2004: 41).

From the sociological point of view, the problem of truth in mathematics isn't so simple as it seems – in modern mathematics establishment of truth is often caused by the sanction of mathematical community (Nathanson, 2008: 773). A little different approach suggests P. Ernest (2016) who considers that the absolute validity of mathematical knowledge is the myth which has developed historically. In the history of mathematics all changeable, doubtful and challenging to the available knowledge has been forced out by constant and predictable (Ernest, 2016:

391). So, it's a kind of the rhetoric of mathematics. If we can find such a relation in mathematics, what is to tell about economics?

As we noted above, in economics the question of model's conclusions compliance to reality connected with a discussion about legitimacy of search of empirical confirmation for provisions of economic theories. At the same time, in economics, as well as in mathematics, there is the coexistence of the theories contradicting each. But it is not a question of logic and its opportunities, it's a question of specifics of economic objects. They are entered in more general field of society, culture and history.

How do differences in understanding and establishment of truth influence the interaction of economics and mathematics? D. Rodrik (2015) notes that economists use mathematics for two reasons:

- clarity and transparency of formulations of basic elements of model (prerequisites, mechanisms of behavior, conclusions);
- ensuring the internal sequence of model (receiving conclusions strictly from prerequisites).

Therefore, economists apply mathematics only as the convenient tool (Rodrik, 2015: 18-19). But separate economic research and economic practice (for example, reforms in the field of medicine, science and education in Russia) show seductive the mathematical understanding of truth for economists is. For example, there is a problem of efficiency, where there is a mixture of economic and mathematical idea of truth. Perhaps, it occurs because "truth and knowledge are inseparably related, not only to interests but to values. Truth itself is a value" (Knight, 1940: 26).

## 5. CONCLUSION

As for economics, the problem of determination of the subject limits of discipline is represented more difficult, than in case of mathematics. It connected with specifics of the economic reality itself which exists in the borderland between social, humanitarian and natural sciences. The mathematical reality is characterized by high abstractness, mathematical objects are the product idealization. Therefore, economics needs external criterion of truth, and mathematics doesn't. Although homo economicus can be quite an abstract model, it still needs correlation with social and economic reality, which are very complex.

Consideration of economics and mathematics as science languages (in case of economics – only for social sciences, and mathematics for any science) asks about the nature of language of science. We believe economics can't be the language of social sciences. The formalization in economics under the guise of economic approach falls short of mathematical formalization, and significantly loses out to it in interpretation of knowledge results in a language of certain social science. There is no sense to ask economics to approve mathematics as the language of science, because mathematics perfectly copes with this task. Its claims for this title are quite proved, but with one note: formalization of the contents of science has to assume this contents before any logical calculations, and also has to receive substantial interpretation in a language of concrete discipline.

The philosophical and methodological bases of the neoclassical economic theory send us to certain ideas from the field of philosophy, ethics, sociology, policy. The mathematics relies generally on philosophy – Pythagoreanism, Platonism, Aristotelean formal logic, intuitionism – and on itself. In this sense mathematics is less subject to the influence of mindset of a scientist. The economic truth is strongly connected with conditions of knowledge process, characteristics of the subject and tools of knowledge.

The problem of compliance of economic models and mathematical objects or theorems to reality connected to a determination of an entity of model building in economics and mathematics. Economic models represent abstractions of first order whereas mathematical models are highly abstract, idealized objects. In economics, we distract from properties of real objects, in mathematics we isolate their qualitative (informative) side, and it is not same. In both cases formalization assumes the subsequent interpretation, and the experimental confirmation of outputs from model is not always possible or is followed by essential restrictions.

In our opinion, for the aims of development of more adequate solution of the problem of truth in economics, it is necessary to make the following:

to define what are actually economic purposes, and in what cases they can be crossed with not economic purposes, and philosophy of economics could help with this task;

to clearly understand the borders of methodological expansion of economics to the field of adjacent social sciences, that is the limits of economic approach, and it can

be made only on the basis of studying of the philosophical and methodological bases of an economic theory;

to pay attention to the changes happening in natural sciences and social sciences within a post-nonclassical ideal of scientific rationality;

to think of serious studying of philosophical understanding of man as to develop on the basis of this understanding economics` own multiple models of man, saved from dictatorship of neoclassical economics or any other economic theory. These models, whether it is necessary for research objectives, can include elements from natural and/or other social sciences.

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