Is Using Mathematics and Game Theory in Analyzing Economic Phenomena Scientific?

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In the article, the author presents some arguments concerning the “mathematical method issue” in modern economics. The author shows why some reasons, according to which we should use mathematics in (economic) theory, are not convincing (they are even tautological), and what does mathematization have to do with arbitrariness of the orthodox economic theory. The author also shows why using game theory (a mathematical discipline) in modern microeconomics does not yield knowledge and correct explanation of economic situations and phenomena. At the end, the author presents fundamental questions that form the basis of economic science and its qualitative research methods, and shows what their practical relevance is. The purpose of this article is to argue, contrary to common opinion, that there can be an exact and objective science of economic phenomena that does not necessarily use modern mathematical theories or methods to explain these phenomena.

Keywords: economic science, qualitative research methods, mathematics, orthodox economic theory, game theory, science, explanation

Introduction

Mathematization of economic theory began in earnest in the nineteenth century with economists such as Walras, Jevons, Cournot, Edgeworth. In the course of the twentieth century (and especially after the Second World War), economic theory was becoming increasingly mathematized. Today, using mathematical methods to explain economic phenomena is generally taken for granted. Yet despite this obviousness, it seems that the question of mathematical method in economic theory still has not been entirely and convincingly resolved. There is a minor, but growing discontent about the effects of mathematization in economic theory—this discontent being expressed especially by heterodox economists and also by some orthodox economists. Also, new attempts appear, whose aim is to totally “reorient economics” into direction of non-mathematical qualitative methods of explanation, one of which being “retroduction”, as proposed by Lawson (2003, 2006).

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mathematics in (economic) theory, are not convincing (they are even tautological), and what does mathematization have to do with arbitrariness of the orthodox economic theory. In the second part, the author tries to show why using game theory in modern microeconomics does not yield knowledge and correct explanation of economic situations and phenomena. At the end, the author presents fundamental questions that form the basis of economics and its research methods, and then shows what their practical relevance is.

The purpose of the article is to argue, contrary to common opinion, that there can be an exact and objective science of economic phenomena that does not necessarily use modern mathematical theories (and quantitative methods) to explain these phenomena. The following argumentation should make this clear. A decision for using mathematical theories before actually knowing what economic phenomena are (what their unique quality is) may not be scientific and objective after all.

**Why Some Reasons According to Which We Should Use Mathematics in Explaining Economic Phenomena Are Not Convincing**

Let us treat the fundamental question: Is using mathematics (and quantitative methods) in explaining economic phenomena reasonable, does it make sense, is it logical? In this chapter, the author presents some conclusions and doubts by a group of German thinkers GegenStandpunkt (2003b, 2004a) regarding the “use” of mathematics in the orthodox economic theory (hereafter, OET).

In the OET, some authors (e.g., Rapport, 1980) have argued that there are many supposed advantages of using mathematics in explaining economic phenomena. In the OET, there is the following false appraisal of mathematics as the superior method for explaining economic phenomena.

**Mathematics Is Supposed to Be “Exact”**

In the OET, it is believed that mathematics is supposed to be exact, and this “exactness” property is supposed to distinguish mathematics from other sciences. Orthodox economists, therefore, believe that by using mathematics, a thing called “exact science” is supposed to be created. But “exact science” is a tautological determination, because science precisely means that we exactly (by inference) find out (and then express in propositions) determinations of an object which belongs to this and only to this object, and that is also why we never find out, how a science would look like if it did not proceed in an exact manner, and what errors would such a science make in this respect.

Which proposition is more “exact”?

1. In the present global capitalism, the fundamental and predominating purpose of companies and their owners is to unconditionally, constantly and limitlessly increase profits, measured in monetary units, i.e., to make more money out of invested money as much as possible, to increase market value of investors/owners’ investments (Companies have other goals as well, e.g., customer satisfaction, care for employees, protection of natural environment, social responsibility, however, all these other goals are subordinated, they are only means to the fundamental goal of making profits).

2. Free fall of bodies in the Earth’s gravitational field is subjected to the law:

\[ h(t) = h_0 \cdot \frac{gt^2}{2} \]  

(1)

whereby \( h \) signifies height at which a body resides in time \( t \), \( h_0 \) signifies initial height at which a body resides, \( g \)
signifies acceleration of falling of bodies by Earth’s gravity, and \( t \) signifies time. This general determination of free falling of bodies in Earth’s gravitational field is the inner principle that governs all coincidental appearing forms (realities) of free falling of bodies in Earth’s gravitational field. And this general determination (inner principle) is the necessary connection of all essential elements of free falling of bodies in Earth’s gravitational field—height, time and acceleration of falling of bodies by Earth’s gravity. This inner principle of free falling of bodies in Earth’s gravitational field is the same in all coincidental appearing forms (realities) of free falling of bodies in Earth’s gravitational field. This general determination (inner principle) is thus the identity (essence, unique property, a foundation) of free falling of bodies in Earth’s gravitational field. The law of the free fall phenomenon is unique quality of this phenomenon.

Both propositions ((1) and (2)) are true. Yet despite this, the second proposition is supposed to be, in contrast to the first one, more “exact”. But why? Because the second proposition (free fall) includes an equation? Because \( h, h_0, v, g \) and \( t \) are measured and numbered? If two propositions are true, then none of them is more “exact” than the other. If we express a certain proposition as an equation, then a law (principle), that is being expressed by this proposition, does not lose anything on its validity (truth), if we express this law in a sentence. A path \( v \), travelled by a body in a free fall, is subjected to the law:

\[
v(t) = \left| h(t) - h_0 \right| = \frac{gt^2}{2}
\]  

(2)

We can express equation (2) in a sentence: “A path, which is travelled by a body in a free fall, increases by the square of time that is needed by a body to travel this path”. Both expressions (equation and a sentence) mean the same thing and both expressions express a true thought. If a certain proposition expresses a law that determines connection between elements that are measurable and numbered, then this does not make any difference concerning precision and validity of this proposition, but only shows different properties, quality, of objects that we explain. The reason why the equation of the free fall appears as the necessary quantitative relationship of elements height, time and acceleration of falling of bodies by Earth’s gravity is only in that the free fall has this relationship as its own unique content, its inner quality. However, addressing this equation as “exact” asserts precisely the opposite: in order to present the free fall “exactly”, we chose numeric symbols and an equation as tools for this exact presentation.

In the OET, “exactness” is being principally and automatically praised, regardless of propositions’ content and regardless of whether these propositions are true or false. It is believed that greater “precision” may be attributed to the proposition (2), and by this “precision”, some other qualities of propositions are meant which is different from content and validity (truth) of propositions. In the OET, “exactness” is attributed to the method of explanation in mathematics (or physics). And in this manner, a form of mathematical-physical laws is separated from their content, and this form is then believed to be the foundation (reason) for these laws. In reality, the opposite is the case: A form of equation is attributed to the law of free falling of bodies precisely because this law is this quantitative relationship between path, time and acceleration. But not the opposite is the case, the free fall law does not have this equation for its content, because some mathematical thinker decided to use this form of equation as some instrument for comprehending the free fall. And finally, the attribute of “exactness” does not disprove the validity of the proposition about profits, nor does it prove the validity of the proposition about the free fall.
Numbers Are Supposed to Be “Exact”

Exactness/precision is not a property that is immanent to numbers, because exactness is a particular demand that we claim in relation to numbers as well as to all other determinations of a certain object. For example, number $\pi$ is a transcendental number and has only one and definite, determined value. We can state the value of the number $\pi$ as 3.1416, or more exactly as 3.1415926535898, or still more exactly as 3.14159265358979323846264338327950288418716939937510. These are three differently exact/precise determinations of the value of number $\pi$. The second determination of the number $\pi$ is much more exact than the first determination and much less exact than the third determination of the value of number $\pi$. Yet despite these differently exact determinations of the value of number $\pi$, this number $\pi$ has only one, definite and determined value which is stated by the above three determinations in three different levels of exactness. And also, the difference between, e.g., number five and number -6389476.69438769466743899866606876 is not that the second number is much more exact than the first number. Number five is number five and nothing else, and the same is true for the second number. Exactness is not a property of numbers.

Which proposition is more exact?

(3) In the Earth’s gravitational field, bodies fall on Earth with an acceleration of $g = 9.80665 \text{ m/s}^2$ towards the centre of the Earth. (This acceleration is different at different places on the Earth’s surface and at different distances from the sea level. German institute DIN (Deutsches Institut für Normung) determined $g = 9.80665 \text{ m/s}^2$ as the normal value of this acceleration).

(4) In the present human society, democracies are states based on the rule of law.

Both propositions ((1) and (2)) are true. If someone would not know what exactly the second propositions means, then he would doubt whether this proposition is true, and he would precisely want to know what this proposition means, and until he would not know this, he would not regard this proposition neither true nor false.

But there is no difference in exactness of both propositions. Every attempt of making the second proposition more exact and sharp through numbers does not make any sense. What are we supposed to count here anyway? Laws, policemen, court procedures, prisoners? In dictatorships, there can be just as many laws, policemen, court procedures, prisoners as in democracies.

Inexact, however, would be the following two propositions:

(5) Acceleration is rather big;

(6) In Turkey, there are again almost democratic relations.

In both of these two propositions, we do not know exactly where we are at. In the first proposition, a need for number values that reside in the nature of hereby stated determination is not satisfied. A certain physical quantity is being discussed, but some definite and determinate value of this quantity is not stated. In the second proposition, a determination is put forward for which it is said at the same time that it is not valid. We could say just as well: In Turkey, a real dictatorship does not rule any more.

Numbers Are Supposed to Be “Objective”

If we treat the proposition “In the present human society, democracies are states based on the rule of law”, then we cannot see why this proposition is supposed to be less objective than the proposition “In the Earth’s gravitational field, bodies free fall on Earth with an acceleration of $g = 9.80665 \text{ m/s}^2$ towards the centre of the
Earth”. We can also not see how we could make the second proposition more objective. Against this, it can be argued that we can determine numbers objectively. Here, “objectively” is supposed to mean that there are measure devices and measuring procedures that determine quantities completely independent from wants and opinions of subjects, while no similar trust evoking “trans-subjective” procedure for qualitative propositions is at our disposal. A great problem of such conception is that we would like to trust our reason much less than some technical devices that function as an auxiliary tool for discovering laws of objects. Measuring/technical devices themselves, just as their purposeful use, are feats of reason. We all agree that in the present human society, democracies are states, based on the rule of law, and we agree upon this without measuring devices.

Language of Mathematics Is Supposed to Be “Unambiguous”

Yet despite this supposed unambiguity, it is generally known that very few people understand mathematics. If in a mathematical text, it is written that:

$$\frac{d}{dx} \tan x = \frac{1}{\cos^2 x}$$

Then this means the same as: “The first derivative of tangent function equals the inverse value of a square of cosine function”. And since both expressions assert exactly the same thing, no expression is more unambiguous than the other. Using signs (symbols) does not create unambiguity of concepts and thoughts, but on the contrary, using signs presupposes this unambiguity. In order to reasonably use a certain sign, e.g.:

$$\frac{d}{dx}$$

We must first know what a derivative of a certain function is. And if we do not know this, or if we have only a faint image of this, then signs are of no help to us. A completely different question it is, however, that we can express our thoughts through language (and thus also through signs) somewhat incompletely, somewhat ambiguously. However, all examples of how using a language can lead to errors do not prove what is wanted to be proved, and that is a fundamental deficiency of language. The fact that mathematicians use special signs has practical reasons—it is much easier to use signs than complex word structures. And finally, there are very few signs that would have so many different meanings as a sign \( x \) in mathematics. In every chapter of a mathematical text and in every mathematical text, this sign has a different meaning. Even in the above formula, the \( x \) sign is used in a double sense: In expressions, such as \( \tan x \), we can insert numbers for \( x \), but exactly this cannot be done in the expression \( dx \), and therefore also not in the whole expression.

Mathematics Is Supposed to Be “Logical”

In mathematics, false inferences do not appear. However, we know that we can make errors in inferences (or in computation). For mathematicians, it is very important that their propositions and inferences are valid, that they are correct, especially they let nothing “pass through” without a proof. But what is to hinder other sciences that in their field of study, they also insist and endeavour as much as possible to make correct and valid inferences and proofs? There is no convincing reason why other sciences cannot be logical and provide correct explanations.

Mathematics Is Supposed to Be “Universal”

In the OET, mathematics is being praised as a purely formal theory which has no concrete content and can therefore be “universally” used. But mathematics in itself is not without content: numbers and laws of calculation, equations and laws of their solutions, functions and their laws of continuity, differentiability and integrability,
and much more, all these are concrete content of mathematics. Mathematics treats general nature (quality, properties) of certain thought-objects (e.g., sets, numbers, measures). And mathematical theory is a set of theorems and proofs, which are derived from certain primary and elementary propositions (axioms), upon which proofs of all other theorems depend.

Mathematics can be used for many different contents, and it can be used precisely because it has its own content. The only rational sense in “universality” of mathematics is that if a certain object is determined by, e.g., some functions, then this object is subjected to laws which are valid for all other functions of this kind. However, it is false to imagine that mathematics is universal (adequate for explaining everything) because mathematics itself is without content.

**Mathematics Is Supposed to Be “Verifiable”**

In the OET, mathematics is being praised for being “verifiable”. But “verifiability” is no special determination that is supposed to distinguish mathematics from other sciences. And “verifiability” is not even some more exact determination of science itself, it is a pleonasm. We verify a certain law/theorem by following (co-thinking) a proof of this law. And after we have followed the proof in its entirety, we then either confirm the law or refute it. And the consequence of a valid law is that individual cases which meet this law, also meet determinations that are expressed by this law. For example, this right-angled triangle fulfils a determination of the law (principle) \( a^2 + b^2 = c^2 \), this body fulfils the law of free falling of bodies, this state fulfils determinations (principles) of a democratic state. Individual case is an illustration of a law and not its proof or verification. A fact, an individual case, an appearing form of an object can never prove (verify) or disprove (falsify) its law, because a law precisely finds/explains facts about an object. And if a certain fact does not meet determinations of a particular law, then this fact does not disprove (falsifies) this law, but only meets determinations of some other law. Measuring billion different right-angled triangles, carrying out a free fall experiment for billion times is not a foundation, a proof of the law. Intensifying a fact that is to be explained does not coincide with an explanation of this fact, with a proof of necessity of its properties (unique quality).

In the OET however, economists want to reverse this relationship of individual cases (facts) and laws by praising “verifiability” in the wrong sense, i.e., they reverse a reason and a consequence: not that a law founds/grounds that its individual cases fall under this law, but on the contrary, these economists think that individual cases are supposed to found/ground a law in the form of a hypothesis (which was our starting point). But if we start investigating an object, not by collecting and verifying facts about an object and then based upon these facts inferring laws (principles) of this object, but by stating some hypothesis about an object, independently from experience and facts, and if we then want to verify on “reality” this hypothesis, we thereby make a triple mistake. First, we interpret facts to which a hypothesis is supposed to refer as cases of this object. If facts (individual cases) would found laws, then why would we want to search for laws and principles of objects anyway, if we would already have foundations, i.e., facts, concrete examples of objects. If concrete examples (appearing forms) of objects would be foundation/proof for laws, then science would be completely unnecessary. If facts, concrete individual cases of objects would find and prove laws of objects, then the question, why a particular phenomenon appears as this is shown by its facts, certainly would not appear. But if this question still would appear, then facts would found themselves, because facts would already be a foundation and a proof—and this would of course be tautological. Facts, concrete examples of objects do not find/explain themselves, but laws, principles, general determinations of objects explain facts and individual cases of objects. Concrete examples and concrete facts about objects are illustrations and not proofs of laws of these objects.
hypothesis. Second, a question which follows from this idealism—do hypothesis and reality “cover”?—in principle does not have a solution, because this question is false, since thought and object cannot be “covered” anyway, and how are determinations of reality supposed to be able to fulfill a certain hypothesis that did not express laws of this reality even at the first place. And third, a question whether a hypothesis and reality do “cover” is in principle already decided: half/half. This is a decision which consistently drives the mistake in hypothesis-thinking until its very end: By stating a hypothesis, we determine, apart from objectivity, some measure/criteria, to which we are supposed to refer the reality. A real objectivity of this reality is and remains something other than this idealism. “Deviation from reality” (as this mistake is expressed in the OET) is thus necessary according to self-understanding of orthodox economists.

Mathematics as an Auxiliary Means—Arbitrariness of Orthodox Economists

Proposed reasons why we should use mathematics in an economic theory are not solid and convincing. What is common to these reasons is some desire for having, by using mathematics, a certain means that would guarantee decent scientific results, so that mathematics itself would automatically take care for correct propositions and would prevent false inferences. But if we want to have correct and valid results, then it is not clear at all, whether in a particular case, mathematics can offer at least some amount of help. “Correct” and “valid” results of research and explanation mean that these results are really determinations of an object that we investigate, that these determinations are exact, that they meet an object, that they are thus specific for an object. Why is a certain object, e.g., some economic phenomena supposed to have exactly and only mathematical determinations? We cannot know this in advance, and inversely, when a theoretician decides that he will treat his object of research with mathematical methods, then this decision is prejudicial and arbitrary, because this choice of some (mathematical) method is not founded upon knowing what this object is and what are its laws. If a theoretician thinks that some mathematical methods themselves are supposed to help him comprehend what an object of his research is, then this is not really scientific and objective, because he would begin his explanation by actually determining how his results should look like (necessarily mathematical). Mathematization therefore becomes the opposite of what it is supposed to be. Mathematics does not serve as an instrument of greater exactness any more, but as an instrument, by means of which a theoretician decides and expresses how he wants to see (economic) phenomena that he investigates, e.g., quantity, function, equation. At the beginning of research and explanation is therefore arbitrariness: as much as it cannot be clear that a particular (economic) object of research can mathematically be grasped at all, so much it is unclear, what mathematical qualities we can assign to this object in particular. Objectivity of a theory thereby disappears before this theory actually begins.

The fundamental mistake by those who want to mathematize an economic theory is that they conceive of mathematics (a mathematical science) as a method. But modern mathematics is not a method, it is a set of theories about, e.g., sets, functions, derivatives of functions, numbers, operations with numbers. Mathematicians state propositions, axioms, theorems about mathematical objects, they prove theorems by using different methods,

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2 What is actually the effect of hypothesis building in economic theory, why hypotheses generated from logical positivist methodology in economic theory are, in practice, nonfalsifiable, why assumptions and hypotheses in economic theory must of necessity be unrealistic, what are fundamental problems in hypothesis building, and why at the end, all that matters is logical consistency of a hypothesis and not a correct explanation of reality (Wilber & Wisman, 1975, pp. 151-158).
they solve different mathematical problems by using different methods. However, there is no one privileged mathematical method per se. Mathematicians immanently think their objects of research, they discover and explain/prove laws and necessary properties of their objects. And that is all they do.

The whole acceptability of mathematizing an economic theory lies in the fact that there are economic objects which are countable and can be numbered, e.g., wages, profits, interests, costs. But quantity, “How much” of these objects does not explain “What” (quality) of these economic objects. In the latter (for example profits and wages), there are contrary and mutually exclusive purposes at work, whereby the second purpose (wage) is entirely a means for the first purpose (profit) which excludes the second purpose.3

Unsatisfactory Results of Using Game Theory in Modern Microeconomics

According to the American Mathematical Society, game theory is an official mathematical discipline (Peters, 2008; Leyton-Brown & Shoham, 2008; Rasmusen, 2007; Osborne & Rubinstein, 1994). This theory is widely used in some modern social and economic theories: “In modern graduate microeconomics, game theory has almost completely replaced calculus as the central modelling apparatus” (Colander, 2000, p. 136). Game theory has been the main microeconomic method in orthodox economic theory since 1980s (Peters, 2008).

In orthodox economic theory (hereafter, OET), game theory is used for the purpose of describing decision possibilities that are available to people in economic situations (Rasmusen, 2007, pp. 12-18). However, in the OET, game theory is not used for the purpose of explaining what people actually do, why they do that and what are consequences of these actions in economic situations. “A game is a description of strategic interaction that includes the constraints on the actions that the players can take and the players’ interests, but does not specify the actions that the players do take” (Osborne & Rubinstein, 1994, p. 2). Also, in the OET, game theory is not used for the purpose of explaining what economic phenomena, e.g., money, price, profit, wage, market are, what are their laws, and why do these phenomena happen/appear.

Using Game Theory in Microeconomics—How Does It Function

Using game theory in the OET functions in the following way: A particular economic situation is defined as a game, people who are active in this situation are defined as players, a choice of behavior in decision-making is defined as a set of alternative actions that are available to decision makers, pay-offs are defined as a mathematical function that assigns a (real) number to every element of a set of alternative actions, optimal action is defined as a relation between mathematical functions, optimal decision is defined as a selection of a particular element from a set of alternative actions, and to every possible outcome, a probability that a particular outcome will happen is assigned (Rasmusen, 2007). So, instead of exactly determining, on the basis of verified facts, what someone in a particular economic situation does (if particular individual situations must be treated), why he/she does this and what are necessary consequences of these actions, some elements (possible actions, choices, utility) of this situation are explicitly defined and interpreted as sets, elements of sets, functions, numbers, measures. In some

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3 For a brief overview on the use of mathematics in economic theory through history (Dow, 1999). For a brief overview on why mathematics is important in modern economic theory, Lawson (cf. 2006, chap. 4). In the Austrian school of economics, which is today generally regarded as one of heterodox economic theories, theoreticians have always tried to reason that using mathematics and models in economic theory is inappropriate and that this “mathematical method” does not yield (universal) knowledge on economic phenomena (Mises, 1977; White, 1984; Wutscher, 2005).
cases, the purpose of such explicit defining of the elements of economic situations by using mathematical objects is to use findings of mathematical game theory for interpretation and representation (but not explanation) of economic situations.

A fundamental finding in using game theory in the OET is that if players (under the assumption that decisions of all other players are known) decide for an action which is supposed to bring the greatest possible utility to all actors at the same time, then this decision will be optimal for all players. The essence of using game theory in the OET is determining those actions which are supposed to bring the greatest possible (real) number to all players in a particular economic situation, and this number is supposed to reflect utility of these actions or their outcomes. Using game theory in the OET is not finding out, how people in economic situations actually decide, but is finding out, how people should decide if they wanted to maximize a (real) number that is supposed to reflect utility of a particular act/decision or its outcome. The result of using game theory in the OET is that the utility maximization is always determined as the reason for choosing an optimal act, even more, utility maximization is always the only reason for choosing an optimal act. By using game theory in the OET, every act of people in economic situations can be described only in relation to the utility function, that is, people choose a particular action because it maximizes a (real) number that is supposed to reflect utility of these actions or their outcomes.

A Response to the Concept of Measurable Utility

Using game theory in the OET is based on the idea that utility can be assigned to a particular action/decision (or to its outcome) by actually assigning a (real) number to this action. And this (real) number is then supposed to reflect utility of this action. Such measuring of actions regarding their utility should then enable a comparison of these actions and determination of a combination of actions, to which the greatest (real) number is assigned, thus “maximal” utility (Webb, 2007; Rasmusen, 2007). However, this idea of utility is contestable, because in determining utility of actions or their outcomes, purposes (wants, needs) that these actions satisfy are not considered. The essence of utility is that utility is determined by a qualitative relation between a purpose (want) and means that satisfy this purpose. Every object and every action is useful in relation to the purpose which is satisfied by that object. It is therefore irrational to compare objects/actions regarding their utility, without first determining purposes that are satisfied (or not) by these objects. Utility is not a property that is immanent to objects. Utility of objects is always determined in relation to the purpose which is satisfied by these objects. Every purpose (desire, need) has its special content, its special extent and its special urgency, and these properties determine whether an object is useful for that purpose or not. Some orthodox economists, such as Samuelson and Nordhaus (2001, p. 85), correctly state that utility is not a psychological function or a feeling that can be observed or measured. They admit that “utility” (a measurable quantity, in analogy to physical quantities that are really measurable), as this concept is used in the OET, is a scientific construct! But if this concept of “utility” is a scientific construct, then this is not an objective and exact determination of what utility really is.

We can also not measure preferences, because preferences are also determined by a qualitative relation between a purpose (want) and how well certain means satisfy this purpose. We cannot assign (real) numbers to preferences. If there are different means that satisfy a certain purpose, then we can order these means according to how well (not how much) these means satisfy this purpose. Satisfying a purpose well or better than some other objects/action, is a qualitative (not quantitative) relation. We prefer an object/action over some other objects
because the first object better (not more) satisfies a certain purpose. And we cannot compare wants according to our preferences, we can only compare objects that satisfy a certain want according to our preferences. We either want something or we do not, but we cannot prefer a certain want over some other want. Preferences refer only to objects that (well or less well) satisfy a particular want.

It is also somewhat irrational to try to determine an optimal action/decision (or its outcome), without first determining the purpose which is satisfied by these actions. And besides, everybody tries to satisfy his/her purposes optimally—optimality is always already included in the realization of a particular purpose. It is therefore unreasonable to isolate and determine, besides all the purposes that we try to satisfy, some separate and independent purpose of utility optimization or utility maximization that we are supposed to achieve. Every purpose that we try to satisfy, we try to do it well, whereby it is not necessary that everybody will always actually realize all of his/her purposes (wants) in the best possible way. There is no independent and separate purpose of utility maximization. But the result of using game theory in the OET asserts exactly the opposite—utility maximization is always determined as the only reason why a person in an economic situation chooses a particular action.

**Mathematical Interpretation—Not Explanation**

By using game theory in the OET, elements of economic situations are explicitly defined as sets, elements of sets, functions, numbers, measures. If in explaining economic situations and phenomena, we decide in advance that in explaining these phenomena, we will use only mathematical determinations, it may happen that we will thereby abstract/ignore those economic determinations that may be essential for explaining these economic phenomena. If we want to exactly determine what economic objects are, that is, what are their laws, principles (fundamental purposes), then it is not enough to assign only mathematical determinations to these objects. Mathematical determinations are thought-forms—sets, elements of sets, functions, numbers, measures are thought-objects and not economic phenomena. Mathematical determinations are objects that are immanent to thought itself. To every object that we think of, we can assign some mathematical determinations, e.g., set, number, measure, exactly because we think of this object. Hegel (1832) thought of a set, unit, quantity, number, measure as only one of many thought-forms—other thought-determinations are, e.g., quality, being, nothingness, becoming, something, essence, positive, negative, contradiction. Georg Cantor (1932), a founder of mathematical set theory, believed that with the concept of a set he defined something that is related to Platonic eidos (idea). Mathematicians that followed Cantor and his set theory also conceived of sets and numbers as thought-objects (Deiser, 2004, sec. 1, chap. 1). Numbers and other mathematical objects are things that belong to thought itself.

Every object is a unit, is a set of elements, every object has its quantitative aspect. However, the fact that we can assign some mathematical determinations to every object that we think of, does not mean that every object is determined only in mathematical determinations. And exactly because every object is a unit, a set of elements, exactly because every object has its quantitative aspect, then in order to explain, e.g., physical, chemical, biological, cognitive, social objects, we need other categories by means of which we determine and explain laws and essence of these other non-mathematical objects. Determinations, by means of which we explain an object, are derived from facts about this object and have to be essential for this object.

Every material object or phenomenon is not determined only in mathematical determinations, but is determined by other material determinations, e.g., length, mass, time, temperature, energy, velocity, that are
different from mathematical (thought) determinations. Every material object or phenomenon is determined in material determinations, and every material determination has necessarily its quantitative determinations, e.g., one meter, five grams, 5.6968 seconds). And these material determinations do not determine mathematical objects—it is not a determination of a number that it weighs five grams, and it is not a determination of a function in set theory that its length is one meter. And every economic phenomenon is also not determined only in mathematical determinations and material determinations, but is determined by means of other economic determinations, e.g., production, labour, consumption, distribution, management, disposal, needs, goods, government/power, institutions, purposes) that determine laws (necessary connection of essential elements) of economic phenomena. Determination of every non-thought, e.g., economic object does not get exhausted in mathematical and other thought determinations—determination of this non-thought object is determined in other determinations that are inner and necessary for this object. Money is not determined only by being a certain unit, by appearing in certain quantity which can change, nor is money determined only by being a certain measure and that some other measures quantitatively exert influence upon this measure, nor is money determined only by being a certain material object, but the essence of money (which is an economic phenomenon) is determined by a necessary connection of other determinations that are economic and not mathematical or material—a determination of money, for example, are inner principles of money that are the same in all appearing forms of money, and these inner principles of money are nothing but a necessary connection of all essential elements of money, e.g., production, labour, consumption, distribution, management, disposal, needs, goods, government, institutions, purposes.

Mathematical Theory as a Tool for Development of New Theories

In the OET, game theory is used as the main method for investigating and describing microeconomic phenomena. So, in the OET, a certain mathematical theory is used for development of some separate theories (microeconomics). But every theory is about some definite objects, and if we want to use this theory for development of some new and separate theory, then this separate theory will necessarily also be a theory about this definite object and not about some other objects. However, if a theory that we want to use for development of some new and separate theory, and this new separate theory itself have the same object of explanation, then these two theories are necessarily the same, and the reason for this is that we already presupposed that a theory about this object already exists and is valid, otherwise we would not have used it. Using a theory for development of some new and separate theory necessarily means that these two theories are the same. Mere using of a theory thus never produces some new and separate theory. If we want to use a certain theory for development of some new/different theory, then such purpose is contradictory, because using a certain theory for development of some

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4 In physics, theoreticians grasp their objects of research by putting identity of these objects in general determinations and laws. In their results, physicists (just as any other scientists) do not allow that their objects would exist in their immediateness, but persist that there is the reality and truth of general determinations and laws. And by doing this, physics presents itself as an activity, which is aimed at objectivity—knowledge. Physics also presents itself as non-contradictory and logical—general determinations that are discovered by physicists which are identical to the object of research. Physics is generally considered as an “empirical science”, but “empirical” in this expression refers only to the characterization of objects of research in physics. Just as any other science, physics is precisely not empirical, because in its results, it goes beyond empirical immediateness of its objects. This is already shown by early achievements in mechanics, such as the law of the free fall or the law of inertia, that are not found in every day experience—they are found in experiments. In physics, obviousness is taken away from categories of objects of research, and physicists impose quantum-mechanical paradoxes upon the “common” sense. This shows that physicists bring their scientific comprehension of objects into life also against immediate presentation of their objects of research. A decisive means of comprehension and discovery in physics is experiment (GegenStandpunkt, 2004b).
new and separate theory necessarily means that these two theories are the same and not different. We can use a theory about an object to learn what this object really is, how does it function, and upon that basis, we can then bring our practical purposes in relation to that object. However, we cannot use a theory of an object to fully develop some other theory of another object.

Game theory is a theory about some possible decisions/actions and strategies of players in a game, and this theory is not a theory about, e.g., money, market, price, profit, credit, capitalism. It is also not a theory about what people in existing economic situations actually do and why they do that. Constructing quantities (utility and its maximization) and interpreting elements of economic situations by using game-theoretical categories and expressions may not be scientific (yielding correct explanations and knowledge) and objective (referring to objects themselves) after all.

Some cases of using game theory in the OET are also performed in basically hypothetical situations, for which it is not necessary that they have ever happened or do happen or will ever happen (Rasmusen, 2007). The author proposes to say that one of the purposes of treating these hypothetical situations is to prove suitability of mathematical game theory and its results for interpretation of economic situations.

From Fundamentals of Economic Science to Science Itself

So far, the author has tried to argue that using mathematics (and game theory) is not really a satisfactory approach (method), if our aim is to explain and understand what specific economic phenomena are about. The author has argued that automatically choosing and using mathematics (modern mathematical science and its various methods) for explaining economic phenomena may not even be scientific and objective after all. But if this mathematization approach is unsatisfactory, how are we then to proceed? In the following, the author proposes an explanation of what economic science is and what its research methods are.

Economic Science and Its Research Methods

Economic science is a social science that treats organization (order) of labour, production, distribution and consumption of goods and services in a specific human society. The fundamental questions that form the basis of economic science and its research methods are the following:

1. What is a certain economic phenomenon, what are its necessary properties? (e.g., What is capitalism, what is money, what is credit, what is crisis?);
2. What are essential elements of a certain economic phenomenon and what is their necessary connection? (e.g., What are essential elements of profit making in companies and what is their necessary connection?);
3. What necessities does a certain economic phenomenon follow? (e.g., What necessities do credits/companies/wages follow?);
4. How does a certain economic phenomenon function and what are its necessary consequences? (e.g., How does capitalism/socialism/mercantilism function and what are necessary consequences of these economic systems?);
5. What happens when a certain economic phenomenon takes place? (e.g., What happens when banks give credits, what happens when companies compete on the market, what happens when investors speculate on financial markets?);
(6) What is the reason/cause for a certain economic phenomenon? (e.g., What is the reason for crisis/unemployment/poverty in capitalism?)... or in practical terms;

(7) What is the purpose of a certain economic phenomenon? (e.g., What is the purpose of capital/money/wage labour/private property/market?);

(8) What people actually do when they follow their economic purposes? (e.g., What do managers do when they follow their goal of profit making?).

These are all qualitative questions for which qualitative research methods are necessary. The basis for economic research is getting experience of economic phenomena, our acquaintance with them, facts about these phenomena. We find out (verify, confirm) these facts by talking to people and asking them questions (interviews, questionnaires), by reading what people write (documents), by observing what people do and what decisions they make, and by observing consequences of people’s actions/decisions. These are all qualitative research methods and they provide us with the necessary material for the scientific activity proper, i.e., explanation of facts. Economists determine and explain the unique content of purposes and decisions that govern human actions regarding organization of labour, production, distribution and consumption of goods and services in a particular human society. The purpose of economic science is to find out unique quality (unique and necessary content, i.e., necessary properties) of economic phenomena.

For example, based on our practical activity (qualitative research methods) of talking to people and asking them questions (interviews, questionnaires), of reading what people write (documents), of observing what people do and what decisions they make, and of observing consequences of people’s actions/decisions, we conclude that in the present global capitalism, the fundamental and predominating purpose of companies and their state and private owners is to unconditionally, constantly and limitlessly increase profits, measured in monetary units, i.e., to make more money out of invested money as much as possible, to increase market value of investors/owners’ investments. Companies have other goals as well, for example, customer satisfaction, care for employees, protection of natural environment, social responsibility. However, all these other goals are subordinated (they are only means) to the fundamental goal of making profits. So, this is a qualitative answer (based on qualitative research methods) to a qualitative question on what is the purpose of companies in the present global capitalism. However, the content of this qualitative determination is partially also quantitative, since it is stated that companies want to increase the quantity of money (capital) which they own. But the method of coming to this conclusion about the purpose of companies is totally qualitative, but not some mathematical or some quantitative method.

Science Is Qualitative

The above stated fundamental questions are not only fundamental for economic science, but are fundamental for science itself. In logic, a fundamental question is, what is a certain thought-category, what is the necessary connection of all the essential elements of this category (Hegel, 1832). In mathematics, a fundamental question is, what is the necessary connection (a law, a theorem) of all essential elements of a certain mathematical object/operation, what necessities these objects/operations follow. In physics, a fundamental question is, what is the necessary connection (a law) of all essential elements (physical quantities) of a certain natural phenomenon, what necessities these phenomena follow. Social scientists explain what necessities social objects follow, which means that they determine purposes that predominate in a society and determine social objects
Purposes are laws for social objects (Decker, 1982).

All the above stated fundamental questions of (economic) science actually boil down to one simple, yet deciding qualitative question: what a particular (economic) phenomenon is, i.e., what is the inner principle/law (necessary connection of all essential elements) that governs all coincidental appearing forms (realities) of this phenomenon. Science determines unique quality (identity, essence, inner necessity) of an object which remains the same in all coincidental appearing forms (realities) of this object. Science determines unique content (which can be quantitative, but not necessarily) of an object; science discovers and explains laws of objects. In its principle, science has a totally qualitative method.\(^5\)

And that is a rather different conception of science from what Milton Friedman believed to be the essence of science: “The ultimate goal of a positive science is the development of a ‘theory’ or ‘hypothesis’ that yields valid and meaningful (i.e., not truistic) predictions about phenomena not yet observed” (Friedman, 1953, p. 7). Science is not about making predictions, but explaining objects/phenomena, which means that we comprehend the inner necessity of an object. And only after we have explained an object, can we then make correct predictions, but whether we can predict some future appearing forms of phenomena totally depends on the explanation and therefore on the nature of these phenomena. We can explain what money is or what price is, but we cannot predict how much a piece of food will cost at a particular market in 2100. However, we can exactly predict future (and past) examples of solar eclipses.

By determining an (economic) object we state correct, valid and exact propositions, we infer, we derive, we prove, and we conclude. Determining law(s) (explanation and founding) of an object means that we immanently think this object; it means that we create a concept of this object. Explaining and founding means going beyond immediate presentation and diverse appearance of an object into determining its law(s), which stay(s) the same in all coincidental appearing forms (realities) of this object. Explanation and founding of an object originate from the object itself—from its unique quality—and not from prior assumptions/positions/paradigms/commitments about this object or reality in general, because that would be arbitrary. An (economic) object itself is the only

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\(^5\) Hegel begins science of logic, whose purpose is to develop a concept of science itself, with quality (determinateness), and only subsequently develops concepts of quantity and measure. Quality is absolutely primary, and only afterwards comes the necessity of quantity and measure. "Quality is the first, immediate determinateness, quantity is the determinateness which has become indifferent to being, a limit which is just as much no limit, being-for-self which is absolutely identical with being-for-other—a repulsion of the many ones which is directly the non-repulsion, the continuity of them... Quantity is sublated being-for-self, the repelling one which related itself only negatively to the excluded one, having passed over into relation to it, treats the other as identical with itself, and in doing so has lost its determination: being-for-self has passed over into attraction. The absolute brittleness of the repelling one has melted away into this unity which, however, as containing this one, is at the same time determined by the immanent repulsion, and as unity of the self-externality is unity with itself. Attraction is in this way the moment of continuity in quantity" (Hegel, 1832, pp. 387, 395). Quantity is what is absolutely external to being (quality) yet necessarily connected to it. And these latter propositions on quantity are all qualitative determinations of what quantity is, of what is its essence (unique quality). Also, counting, calculating, operating with numbers (finite or transfinite), these are all quantitative methods and they are predominantly practical activities, not theoretical. These quantitative methods are not what science is about. Science (mathematics in this case) searches for laws (general determinations, unique quality, inner necessities) of calculations, operations with numbers, and these laws are then expressed as axioms or theorems—mathematics as science consists in finding these laws and in proving their validity, nothing more. In physics, for example, measuring is a practical activity that provides necessary material for theoretical (i.e., scientific) work proper, i.e., determination and explanation of quantitative relationships between measurable physical quantities. Science is thus not about quantitative methods and measuring, science means stating propositions, inferring, deriving, proving, concluding, eliminating mistakes, contradictions and tautologies. And the results of such correct thinking are qualitative determinations of what objects are, what are their laws, what is their unique content (which can be quantitative in nature, but not necessarily). An accountant constantly counts, calculates, operates with numbers, i.e., practices quantitative methods, usually by using computers), but nothing of that practical activity whatsoever makes him a scientist.
criterion of thought and explanation. And finally, by determining laws of objects, knowledge (understanding) of these objects is created (GegenStandpunkt, 2005, 2007; Decker, 1982; Hegel, 1832).

Comprehending the essence of an object always presupposes that we are acquainted with this object, i.e., with its various appearing forms. However, being merely acquainted with an object does not necessarily mean that we have also comprehended it. We are all acquainted with money, for example, but have we also comprehended the essence (laws) of money in the present economic order?

A law (inner principle, unique determination/quality, a necessary property) of an object is not some other objects. Therefore, we cannot explain an object through some other objects. Explaining an object through some other objects or explaining an object through relations, in which this object stands with other objects, is inadequate, because such “explanation” does not determine the inner necessity (unique quality) of an object, but only a relative necessity of an object. In such “explanation”, a question always appears, whether a certain first object is the only cause (or factor) of some other second object, or are there yet other objects that are also a cause (or a factor) of this other second object. And if none of these objects by itself does not explain this other second object, then how can these objects together explain this other second object? Explaining an object through some other object(s) is inadequate also because it necessarily leads either into tautology (total identity of an object and a thing that founds this object) or into contradiction (limitlessly infinite regress) (GegenStandpunkt, 2005, chaps. 5-6). A world is not a limitlessly infinite chain of objects and phenomena, in which every object is a consequence of some other objects, and at the same time, a cause for some other objects. A world is simply full of objects and phenomena, and objects that exist in a world, do not exist there because of some primary necessity, but every object has its own inner necessity (inner principle), a law of functioning, which does not mean, that the existence of these objects is necessary.

Every object, that is an object of our experience, has its own inner principle (unique determination) and therefore demands its own explanation. Knowledge about an object is independent from knowledge about other objects. The question of “why” of an object thus necessarily goes over into the question of “What is this object?” and aims at a law (inner principle) of this object—and this law explains/founds all coincidental appearing forms (realities) of this object and stays the same in all these appearing forms. Categories “reason” and “cause” are tautological and contradictory, as long as they aim either at total identity of an object with its reason/cause or at the mediation of an object through some other object(s). Categories “reason” and “cause” make sense and are logical only in that they aim at an inner principle of an object that governs all coincidental appearing forms (realities) of this object. A reason/cause for the fact that an object appears in such forms, as it does, is only in laws (necessary connection of essential elements) of this object and not in some other objects. Also, a reason/cause for specific elements of an object, for their necessary appearance, lies in laws of this object, in the way this object functions, and not in some other objects, e.g., crisis is a specific element in capitalism and the reason for necessary appearance of crises in capitalism are laws of capitalism, the way capitalism functions. A reason/cause
of an object always lies in an object itself and not outside of it (GegenStandpunkt, 2005, chap. 7).

**Practical Relevance of Economic Science**

If we know what an (economic) object is, what is its inner principle (inner necessity), then we have certainty in relation to what object we are dealing with in our experience. And if we have this knowledge (certainty), then we can ask ourselves how we want to use this object (in the case of natural phenomena) or, in the case of social phenomena, how we value and judge this phenomenon, whether we want this object (and would like to improve it), or whether we are against this object. Then we can rationally act in regard to whether and how we want to deal with this object. Only on the basis of knowledge about an object can we rationally decide, how we will deal with this object. Knowledge is thus immanently practical. For a life that is beneficial to us, we need correct, valid explanations and knowledge.

**Conclusion**

Reasons of why we should use mathematics (modern mathematical science and its various methods) in explaining economic phenomena are not very solid and convincing. In the OET, there is somewhat false appraisal of mathematics as some superior methods which almost automatically guarantee exact and objective results. A fundamental problem of all those who want to mathematize economic theory is that they conceive of mathematics as some privileged methods that can be universally and automatically used. The author has argued that mathematics (a modern mathematical science) is not a method, but a particular theory (explanation) on certain thought-objects, e.g., sets, numbers, measures, functions, equations. However, mathematics should serve as a role model, not in the sense that it is some superior method of explanation, but in the sense that mathematicians immanently think their objects of research, in that they really discover laws (unique quality, necessary properties) of these objects, and therefore really provide knowledge on these objects. And only in this respect should mathematics serve as a role of model.

A fundamental problem in using game theory in modern microeconomics is that a mathematical theory on games is being used for development of a new and separate economic theory on economic situations. The author has argued that this procedure is contradictory. Another problem is that the purpose of using game theory for economic situations is not to correctly explain past or present real economic situations (or even economic objects with which we are dealing in practice), but only to mathematically interpret and represent (model) real or hypothetical economic situations by using only mathematical determinations (and therefore abstracting/ignoring essential economic determinations). Using game theory for economic situations is also based on a very contestable conception of utility, because this conception abstracts from purposes (wants) which particular objects/actions are supposed to satisfy.

The fundamental questions that form the basis of economic science and its research methods are all qualitative and these questions are not only fundamental for economic science, but are fundamental for science itself. They can be reduced to one simple, yet deciding qualitative question: What a particular (economic) phenomenon is, i.e., What is the inner principle/law (necessary connection of all essential elements) that governs all coincidental appearing forms (realities) of this phenomenon. Science determines unique quality (identity, essence, inner necessity, necessary properties) of an object which remains the same in all coincidental appearing forms (realities) of this object. Science determines unique content (which can be quantitative, but not necessarily)
of an object, science discovers and explains laws of objects. In its principle, science has a totally qualitative method. Correct and valid answers to these fundamental qualitative questions provide us with knowledge that we can use for successfully realizing all our practical purposes.

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