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THE HOLISTIC THEORY OF THE CONSUMER MARKET DEMAND

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Abstract

The paper gives a brief presentation of the reconsideration of the neoclassical individual demand theory, which has occurred to be an inappropriate basis for constructing a collective market demand theory of practical interest. As consequences of this failure, the equilibrium theory created on this reductionistic basis does not reflect economic reality; and the theoretically developed economic approach to indexology is intended in statistical practice and other authors' literature for individuals or households. In the presented reconsideration of the reductionistic IDTh, the study's object is the "statistical ensemble of consumers" of a market observed through trade statistics. This ensemble's rationality is not an axiom, but a hypothesis being verified by the market statistics. These differences correspond to the general scientific character of our reconsideration of neoclassical individual demand theory, namely: objectivity, provability, and verifiability of facts. The rich mathematical and model apparatus of the IDTh has been conserved under the reconsideration. The obtained MDTh provides the economic legitimacy of the holistic equilibrium theory laid down by the works of Gustav Cassel and Abraham Wald, but until now rejected as a scientific direction of economic theory, as well as the "economic" approach in indexology, founded by Konüs, which takes into account consumer preferences to construct market demand's indexes.

Keywords: Collective utility function, failures of economic theory, market demand, statistical consumers' ensemble

1. Introduction

1.1. The problem of Economics scientization

Contemporary neoclassical Economics refers to the Social Sciences (Humanities) with their methodology, which is the methodological individualism, and it is more normative than positive methodology, accepted in the Natural Sciences. Within the framework of this methodology, it turned out possible to create only the individual consumer's demand theory (IDTh), significantly developed mathematically, but impossible to create a collective market demand theory (MDTh) of practical and theoretical interest. The MDTh, adequate to reality, is necessary for the development of equilibrium theory, as a theory of prices that are usually set on markets in stable conditions; and for practical economic analysis. Besides, the equilibrium prices, which depend on the economy's technological and other characteristics, provide its efficacy and competitiveness in the world economy.

Undoubtedly, economic phenomena and processes are specific because their elements are people with the psyche, and their behavior is irregular and often spontaneous. However, for a long time, many authoritative economists believed that Economics, as a cognitive and practical discipline dealing with quantitative measures, primarily prices and quantities of obviously interrelated goods, should satisfy general scientific principles: *objectivity, provability and verifiability facts.*

The scientization of Economics was systematically started by the founders of the neoclassical approach to this discipline, primarily by Stanley Jevons and Leon Walras. They both independently began to revise the conglomerate of economic theories that existed at that time, on the scientific principles laid down in the very developed by that time Physics and Mechanics. However, Jevons and Walras limited themselves mainly to the mathematical formalization of basic economic phenomena, which would provide provability of corresponding theories. Their seminal "Political Economies" founded the mathematical demand theory of *an independent and rational individual consumer*. Walras also laid the basis of th**e** equilibrium theory**.** The founders understood that the object of practical economic interest is not the individual, but *collective market demand*. They and many of their followers believed that the individualistic approach would be a natural and effective means to create a theory of market demand that would be the sum of independent individual demands. However, in the middle of 20th century, a few fundamental failures of the IDTh and the Walrasian equilibrium theory (described below) developed on the base of this theory were revealed.

The process of Economics scientization has a rather hard history. It was accelerated by creating the Econometric Society in 1930 by some well-known economists, primarily by Ragnar Frisch as well as Irving Fisher, the first president of the society. Frisch, introducing the notion "Econometrics" in his 1930 Yale lecture has defined it as the synthesis of Economic Theory, Mathematics, and Statistics to turn the Economic Theory '*into a science in the strict sense of the word*' (Bjerkholt & Qin, 2010, p. 4). Forty years later, in the Nobel Memorial Prize speech Frisch noted two break-throughs have emerged in economic theory since the time of Stuart Mill: *the first* was "*a systematic study of the human wants and their place in a theory of prices*"; *the second break-through* was the "*beginning of the econometric way of thinking*" (Frisch, 1970, p. 16-17)**.** However, these break-throughs turned out to be very bounded.

1.2. The current state and failures of the IDTh

The current state of the neoclassical IDTh is presented in the popular microeconomics textbook (Mas-Colell et al., 2001, Chs 1-4) and the recent textbook (Mandy, 2017, Part. 3). The former book describes comprehensively, without avoiding failures, two approaches to mathematical modeling an individual consumer's rational behavior regarding the choice from the attainable set of goods: *preference-based* and *choice-based*. The latter is an abstract generalization of the former. Here, we confined ourselves to the first approaches that is the classical utility maximization one. Mandy's textbook describes only the preference-based approach and does not concern the neoclassical demand theory's failures. The IDTh is a deeply developed mathematical theory, which has frame elements of the verification technique using the parametric and nonparametric demand analysis according to trade statistics. But in the 1950s years, William Gorman and in a specified form Paul Samuelson stated that the conjecture about the similarity of the theories of the independent individual demand and the sum of such demands was wrong. Samuelson concluded that this model does not apply to a set of buyers, without questioning its applicability to individual buyers. This conclusion of the reputable neoclassical economist was unproven, but neoclassical Economics has adopted the belief that the collective market demand is irrational. Gorman's result is cited and presented in (Mas-Colell et al., 2001, Ch. 4), and some modification of Samuelson's specification is presented in the recent Gorbunov's Russian book[1] cited in papers (Gorbunov & Lvov, 2019; Gorbunov et al., 2020).

Due to Economics' failure, many authors fulfil their researches on the demand theory within the framework of neoclassical microeconomics in behavioural economics; see, for example, (Dannenberg & Estola, 2018; Hlouskova et al., 2019). And despite this failure, Kennet Arrow and Gerard Debreu (1954) modified the Walras' equilibrium model on the reductionistic base with two sets of agents: firms-producers and consumers, each of them acted independently and rationally following their individual goals**.** The authors proved the existence of equilibrium prices, and this paper became the seminal one for the mainstream direction of contemporary Economics. However, within this model's framework, it appeared impossible to prove the uniqueness of the equilibrium except some unrealistic assumptions concerning individual preferences. Moreover, in this model, the typicality of the equilibrium sets' pathologies was revealed (Mas-Colell et al., 2001, Section 17. E, Sonnenschein-Mantel-Debreu theorem).

So, the Gorman-Samuelson "impossibility result" revealed that the reductionistic approach to creating a market demand theory (MDTh) that reflects reality is an inappropriate means, and such a theory is absent in neoclassical Economics so far. This is a fundamental failure of Economics for economic practice and for resolving the main economic theoretical question, which is the Value Theory in positive setting. More about these failures can be read in recent works (Coyle, 2019; Chorafakis, 2020; Estola, 2017; Móczár, 2018; 2020). Matti Estola believes that microeconomics' main failure is the absence of a dynamic theory of consumer demand, firm behavior, and goods markets. Correspondingly, the book of Estola is destined to the dynamization of microeconomics. But he rests in the reductionistic methodology, and it does not allow constructing an MDTh reflecting reality and being verifiable. Diane Coyle examines the Economics' central figure Homo Economicus as a rational, self-interested person

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[1] See http://www.rfbr.ru/rffi/ru/books/o_1945611, pp. 48-54. Accessed 8/26/20.

maximising the utility/profit and concludes that Economics must urgently revisit welfare economics. George Chorafakis (2020) claims that: "*Many epistemic anomalies of the neoclassical research programme[2] originate from its ontologically reductionist meta-axioms, …, the metaphysical foundations of the premise of emergence and … a progressive systemic research programme in economics … can be a remedy to the ills of neoclassical reductions.*" (p. 240). József Móczár (2018) presents the Kornai's struggle with equilibrium theory from the standpoint of institutional economics, and in (Móczár, 2020, p. 42) he explores mathematically "*the role of general equilibrium in economics, relying on a deeper analysis of the Arrow-Debreu model*" as a follower of the 'Anti-Equilibrium' theory of János Kornai, which was founded in Kornai's namesake 1971 book.

Despite the failures of the reductionistic Arrow-Debreu equilibrium model, representing an artificial unrealistic economy, many mathematicians still continue to investigate possible pathologies of equilibrium sets (Balasko, 2016) and algorithmize equilibrium calculations (Nesterov & Shikhman, 2018). There are many attempts to use this equilibrium model as a basis for applied equilibrium analysis, and a recent book introducing this trend is (Cardenete et al., 2017). The authors declare that their equilibrium models presented in the book are an extension of the Arrow-Debreu model. However, their 'skeleton model' (Chap. 3) is essentially similar to the holistic Cassel-Wald model (Wald, 1951), discussed in the next subsection, with a multy-sector (non multy-firms) manufacturing sector and aggregated (market) demand with a priori imposed rationality condition.

Another consequence of the absence in Economics of an MDTh, reflected economic reality, is the blocking the theoretically developed economic approach to indexology, founded by the soviet mathematical economist Alexander Konüs. In statistical practice, this approach is blocked until now. In the international "Consumer Price Index Manual" (ILO, 2004) and in the literature of other authors, economic indexes are intended for individuals or households.

It is necessary to note the Werner Hildenbrand's book "Market Demand" (Hildenbrand, 2016). This and other works on modeling collective consumer behavior are constructed in a reductionistic way and assume information about households' consumption, which is a very restrictive[3].

1.3. Holistic approach to demand theory

The holistic approach to equilibrium theory was actually founded by Gustav Cassel, who reformulated the Walrasian equilibrium model by describing market demand as an initial object (Wald, 1951, p. 370). In the early 1930s, Abraham Wald[4] has investigated an improved Walras-Cassel equilibrium model and introduced an assumption of market demand*, which coincided with the Weak Axiom of Revealed Preference suggested by Samuelson in 1938. With this condition, Wald has proved the existence and uniqueness of equilibrium, and it has called the *Wald's Condition*. But in neoclassical Economics, Wald's result was disqualified because it contradicted the accepted irrationality of market demand accepted there.

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1. **[2] The Program of Microfoundations of Macroeconomics.**

[3] priory. See our review Zbl 1248.91034 on https://zbmath.org. Accessed 09/11/20.
[4] The cited 1951 paper is a translation of his German 1936 paper.

A holistic MDTh has been elaborated and approved in our Russian books and papers, since 2001, of which we note, due to the issue's restrictions, only recent papers (Gorbunov & Lvov, 2019; Gorbunov et al., 2020) where there are other references. Unlike the neoclassical IDTh, where Preference Relation (PR) is a primitive characteristic of an individual, in the holistic MDTh, PR is the primitive characteristic of the *Statistical Ensemble of Consumers* (SEC) of the market under study, and the indicator of the PR is the *collective utility function*. Within this holistic concept, we adopt the basic model of collective consumer choice on a market under study that formally coincides with the neoclassical Jevons-Walras' model of individual choice, but applied to the SEC. Here, by the words Frisch (1992, p. 391) "*The raison d'etre of the following observations lies not in the originality of the formulae but in their economic interpretation.*" Our holistic approach directs not at households that are non-observed for real markets, but at arbitrary market segments presented through regular trade statistics formed by statistical services. Accordingly, we have a verification method for the MDTh on real trade statistics presented in the mentioned above papers of (2019, 2020). This method consists in simultaneous constructing a collective utility function, which rationalizes a given finite set of inexact data of trade statistics, and economic (Konüs' / analytical) indexes. The verified holistic MDTh legitimizes holistic equilibrium models of Cassel type with Wald's Condition having a unique equilibrium and provides economical legitimacy and numerical methods for calculating the analytical indexes for real data.

2. Problem Statement

The paper considers the problem of failures of contemporary neoclassical Economics, which consists in the absence of the theory of consumer market demand and its consequences.

3. Research Questions

The paper's research question is the creation of the theory of consumer market demand on scientific principles, which are *objectivity, provability, and verifiability* by facts.

4. Purpose of the Study

The study's purpose is the reconsideration of the neoclassical demand theory with the conservation of its mathematical and modeling apparatus by changing the axiomatic approach to constructing economic theories to the general scientific approach to investigating real objects or processes.

5. Research Methods

The research is based on economic-mathematical modeling, developing a holistic approach to market demand.

6. Findings

6.1. Market complexity denies reductionism

A possible explanation of the inconsistency between the individual and market demand theories in the contemporary neoclassical Economics is the imposition on isolated independent individuals the rationality principles formed by the founders (Cournot, Gossen, and Jevons) based on the analysis of the joint actions of many people, reflected in trade statistics. Another possible reason that Jevons and Walras began their revision of Economics from developing demand theories for an individual consumer was the often productivity of the reductionistic approach in the natural sciences in studying complex objects[5]. But reductionism has limits as a research methodology in natural science and engineering, where it was revealed rather long ago that complex phenomena are not completely explained by the properties and mechanical movement of their elements. Quite often, in physical, biological, and other systems, new phenomena emerge that their parts do not have on their own with growing their complexity. In cybernetics, such a systemic property is called '*emergence'*.

As a part of the economy, the market system is much more complicated than the systems studied in physics. Market elements are people with a psyche, and their behavior is irregular and often spontaneous. Besides, market behavior is essentially collective; people don't have complete information about goods and prices in the market, and they are subject to mutual and external influences: traditions, fashion, mood, advertising. These features predetermine the failure of the reductionistic principles for describing the market.

6.2. Statistical ensemble of consumers

Our holistic alternative to the microeconomic reductionistic consumer's demand theory is based on replacing the initial object, an individual, by the studied market represented as a whole object through the trade statistics in a previous period. The collective demand is the sum of individual demands on the market, but buyers' sets on almost any market are not observed and changeable. People expend their money in different markets, and the real market process may seem chaotic. But when the market is not subject to strong shocks, trade statistics usually shows steady dynamics that makes it possible revealing objective patterns in the collective behavior of the market buyers. We define the changeable set of the market buyers in terms of the fuzzy sets' theory by Lotfi Zadeh.

Definition 1: The *Statistical Ensemble of Consumers* of the market under study is a fuzzy set of its consumers that has statistical stability respectively the dependence of the quantities of consumption goods' sales on their prices and the total expenditure of all the market's consumers. □

The notion "fuzzy set SEC" means that the SEC is a subset of some universal set C (the country population or the humankind), and elements $c \in C$ have nonnegative membership-measures $m_{SEC}(c) \in [0, 1]$ of their belonging to the SEC. In the considered problem of markets' mathematical

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[5] Firstly, in theoretical physics, reductionism is a natural method, because the main problem here is the basic understanding laws of organizing and proceeding of the Material World. Another example is the molecular-kinetic theory of the explaining macroprocesses in continuous media.

formalization, the measure m_{SEC} can be defined as a part of her/his expenditure in the market under study relative to her/his total expenditure. Since the notion SEC is only conceptual in nature, there is no need to reveal its fuzzy characteristics.

Unlike the neoclassical Economics, there are no axioms that people are rational and independent agents of the economy, knowing all about market prices and goods. The alternative assumption is that *people only want (as a rule) to be rational, and these wants determine the dominant behavior of the market's buyers*. Besides, a more realistic assumption is that *the whole consumer community knows all about the market!* Accordingly, the assumptions about the completeness, transitivity and continuity of the averaged collective preferences, which provides the existence of the utility function being minimized, are more grounding than for an individual; and these assumptions are not axioms, but are accepted as hypotheses being verified on trade statistics. These hypotheses are enough in order to build the classical variant of the market demand theory, considering the given market as a black box, represented by trade statistics of prices and quantities of goods sold over a number of periods.

6.3. The collective utility maximization problem

The current classical individualistic rationality principle of utility maximization in an abstract style (introduced by Gérard Debreu), is based on the notion of binary PR, denoted as $\underline{f}$, that is defined on some consumption set *X* of a good space $R_+^n = \{x \in R^n : x_i \geq 0, i = \overline{1,n}\}$, the vectors of which are columns, and economically $x \in R_+^n$ is a 'consumption bundle'. The writing $x \underline{f} y$, where *x* and *y* belong to *X*, reads as "*the consumption bundle x is at least as good as y*". A PR $\underline{f}$ is rational if it is complete and transitive. If the PR is also continuous, then there is an analytical representation through a continuous function $u : R_+^n \to R_+$, that is, $x \underline{f} y \Leftrightarrow u(x) \geq u(y)$. Such a function is the PR indicator, or the ordinary utility function. Hereinafter, we omit the attribute 'ordinary' and impose on the PR the additional properties of monotone increase and convexity, accepted for the market choice of consumers. The properties of monotonic increase and quasiconcavity for the utility functions provide these properties of the PR.

The possibility of the consumers' choice is mainly determined by the goods' prices p, which are also n-dimensional nonnegative vectors, and all buyers' *total expenditure* $e = p_1 x_1 + ... + p_n x_n$. The last sum is the inner product of the vectors *p* and *x*. In the analytical context, this product is usually denoted as $\langle p, x \rangle$. Now a goods' bundle $x \in R_+^n$ represents all buying on the market during some period, and this bundle, by assumption, maximizes the *collective utility* $u(\cdot)$ with the *expenditure constraint*, were a limiting factor on purchases is not a *wealth,* but the *expenditure* representing all sales in the market during the accounting period:

$$D(p,e) = Arg\max\{u(x) : \langle p, x \rangle = e, \ x \geq 0\}. \tag{1}$$

When constructing a non-trivial demand theory, all prices are assumed to be positive, that is, $p \in R_{++}^n$ (strict positive orthant). The extremal correspondence of problem (1), that is, the Market Demand Correspondence $D(\cdot,\cdot): R_{++}^n \times R_+ \to 2^{R_+^n}$, represents the market's collective rationality. Due to the compactness of the admissible set and the continuity of the objective function, this problem is solvable for any $(p, e) \in R_{++}^n \times R_+$, and the correspondence $D(\cdot,\cdot)$ is compactly defined.

Thus, all the demand's characteristics and properties derived from the Utility Maximization Problem (1) presented in (Mas-Colell et al., 2001, Ch. 3) and in (Mandy, 2017, Ch. 10). are true for our MDTh. We can say that *problem (1) in the holistic setting turns individual chaos into collective order.*

Two of basic characteristics of the demand (1) are:

1) homogeneity of degree zero: $D(tp, te) = D(p, e), \quad t > 0$;

2) expenditure identity (Walras' Law): $\langle p, x(p,e)\rangle = e \quad for \quad \forall x(p,e) \in D(p,e)$.

To construct a meaningful analytical theory of market demand, the PR must have additional properties to ensure the single-valuedness and continuous differentiability of correspondence $D(\cdot,\cdot)$, which becomes the Walrasian (ordinary) market demand function $x(\cdot,\cdot): R_{++}^n \times R_+ \to R_+$ with values

$$x(p,e) = arg\max\{u(x) : \langle p, x\rangle = e, \quad x \geq 0\}. \tag{2}$$

In terms of utility functions, the continuous differentiability of demand function (2) will be ensured if the function that represents the PR is twice differentiable and strictly quasiconcave. In addition, to avoid technical difficulties that are superfluous for economic theory, model (2) is usually considered in the domain of positive (nondegenerate) solutions $x(p,e) > 0$, which are of practical importance. In this regular positive case, problem (2) is being solved or analysed using the classical Lagrange multipliers method.

6.4. Inverse problem of the MDTh

The inverse problem of the market demand theory is the problem of model (2) statistical verification. It consists in constructing a collective utility function via trade statistics, consisting of a finite pries-quantities set $\{p^t, x^t : t = \overline{1,T}\}$ on observing the studying market. Such functional problems of mathematical modeling, as a rule, are ill-posed problems. They may be inconsistent or have non-unique unstable solutions. An ill-posed problem should be regularized, that is, it should be approximated by a well-posed problem that has a unique and stable solution concerning the initial data. Regularization is fulfilled using additional information about solution and, if any, data errors.

In (Gorbunov & Lvov, 2019; Gorbunov et al., 2020), a regularization method for the MDTh inverse problem, based on our Relaxation-Penalty Method (cited there) within the framework of the non-parametric demand analysis of Afriat-Varian, is presented and approved. Here the role of additional information is played by Fisher's statistical consumer demand indexes. Three types of tasks for constructing indexes with characteristics of optimism (low price indexes and high quantity indexes),

pessimism (vice versa) and objectivity are suggested. These tasks have explored on real food statistics. Herewith, the hypothesis of the existence of a collective utility function, which rationalizes these statistics, was confirmed. In other words, the MDTh has been verified on real data.

7.   Conclusion

Simplifying the formalization of the studied object in science is inevitable. Finding effective simplification that provides non-trivial development of positive scientific knowledge about an object is a matter of art and intuition. The reductionistic approach, very approved in the natural sciences, to creating a market demand theory of practical interest, has turned out a blind alley.

Our paper presented a reconsideration of the neoclassical individual demand theory, significantly developed formally, with replacements: the initial object, which is an individual, – by the statistical ensemble of consumers of the market under study; and the rationality axioms for preferences – by the corresponding hypotheses. The MDTh has reconsidered on the scientific principles within the framework of the holistic methodology. It can be verified against real market statistics. Because of the boundedness of any scientific theory of infinitely complex reality, not every market should be non-trivial explained by any demand theory with acceptable precision. A demand theory would have the scientific character if many real markets presented by their trade statistics verified the theory. We have a lot of successive verifications of the presented MDTh. The verification problem deserves extended consideration, as well as the holistic equilibrium theory.

Acknowledgments

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