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IS A PARADIGM SHIFT IN MAINSTREAM ECONOMICS NEEDED IN THE LIGHT OF DEVELOPMENTS IN ARTIFICIAL INTELLIGENCE?

ABSTRACT

Economic researchers have been discussing a paradigm shift in mainstream economics for many years, as economics as a science has ceased to formulate accurate predictive conclusions. Representatives of unorthodox streams of economics, such as institutional economics, behavioural economics or the emerging neuroeconomics, state that the classical paradigm of mainstream economics should be eliminated from research and a new paradigm of economics should be introduced into economic science. Previous attempts to construct such a new paradigm of economics have failed. Artificial intelligence, rapidly developing in the 21st century, brought some hope to those seeking to dismantle the classical paradigm of mainstream economics. In this paper, we present our research on the classical paradigm of mainstream economics. We put forward a research hypothesis stating that the mainstream economic paradigm should not be dismantled, but rather modified. We propose applying data filtering at both the input and output stages to the existing paradigm by constructing various filters. These filters would enable economics to formulate practical conclusions, increase the efficiency of scientific research, allow the discovery of new economic laws, and optimize the decision-making process.

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1. INTRODUCTION

The recent global economic crisis has shown the predictive weaknesses of economics. Well-known economists, such as Nobel laureates J. Stiglitz or P. Krugman and less well-known ones, such as J. de Soto, N. Roubini or T. Sedlacek, comment on the weaknesses of economic theory in very different ways. However, the dominant focus of these discussions involves the issue of changing the mainstream economic paradigm. At this point, it should be recalled that the discussion about the paradigm shift of mainstream economics, has been going on in the literature since the emergence of the research results of unorthodox economics. Especially the achievements of behavioural economics, institutional economics and ecological economics cannot be ignored in the development of economic theory and *eo ipso* in mainstream economics (Noga, 2024).

The authors of this paper do not question the influence of unorthodox economics on the development of economic science in general and the development of mainstream economics. Nevertheless, the results of our research indicate that the paradigm of mainstream economics should be modified rather than eliminated and a completely new paradigm of economics should be sought. The emergence of artificial intelligence in 1956, both in the literature and in socio-economic practice, does not change our position on modifying the mainstream economic paradigm rather than dismantling it. However, the modification of the paradigm of mainstream economics must take place through specific scientific methods and rules of conduct, which will be the subject of the research, presented in this paper.

To scientifically verify the thesis that the mainstream economic paradigm should be modified, we will conduct preliminary analyses of:

- the essence of the mainstream economics paradigm and its shortcomings, particularly in terms of prediction;
- the emergence, development of artificial intelligence and its impact on the development of society and the economy;
- the impact of artificial intelligence on the study of economic reality and forecasting of economic phenomena in the national and global economy.

These analyses will allow us to establish a framework for modifying the mainstream economic paradigm.

2. THE PARADIGM OF MAINSTREAM ECONOMICS AND ITS SHORTCOMINGS

A paradigm is a general concept, pattern or framework of thought that determines how scientists and practitioners in a particular industry or field of knowledge understand and interpret reality. Most commonly, a paradigm includes beliefs, values, guidelines methodologies, rules and principles of practice, techniques for research and interpretation of results, etc., which influence the way in which the field thinks, investigates and approaches problems. A paradigm can be interpreted as a disciplinary matrix, i.e. an ordered set of beliefs, attitudes or convictions shared by scholars practising a particular discipline.

A paradigm is a general concept that influences the way reality is understood and interpreted in a field. In the social and natural sciences, there are many paradigms that define the approach to the study and interpretation of data. Paradigms have beliefs, research methods, theories and rules. In management, too, there are paradigms that shape the thinking and approaches to managing organisations. Paradigms can evolve and change with scientific developments and advances in knowledge.

The paradigm is particularly important in economics, as this science studies human behaviour in the production, distribution and consumption of various goods and services.

The founder of paradigms in science is Thomas Kuhn, who defines a scientific paradigm as:

1) a model accepted by the scientific community;
2) the scientific discipline matrix (Kuhn, 1996).

Scientific paradigms have several distinctive features that determine the way in which a field of science operates.

These include:

- **Fundamental beliefs.** Scientific paradigms are based on core beliefs that are widely accepted in the field. These are the fundamental assumptions that shape how reality is understood. These beliefs may include accepted theoretical models, rules for interpreting data, ontological and epistemological assumptions.
- **Accepted research methods.** Scientific paradigms establish the accepted research methods that are used to collect data and test theories. These may include laboratory experiments, field observations, statistical tests, computer simulations, etc. The choice of specific research methods is linked to the accepted beliefs and values of the paradigm.
- **Dominant theories and models.** Scientific paradigms comprise the dominant theories and models that are accepted in a field. These theories and models provide a working framework that guides research, data analysis and explanation of phenomena. They are built on the beliefs of the paradigm and serve to create a coherent and integrated picture of the field.
- **Rules and norms.** Scientific paradigms have rules and norms that define how scientific work should be conducted. These can be rules about methodological correctness, how data should be presented, standards for scientific publications, etc. These rules help to maintain the consistency and quality of research within the paradigm.
- **Consensus and social acceptance.** Scientific paradigms are based on consensus and social acceptance. Within a given scientific community, researchers usually agree on the core beliefs, methods and theories of the paradigm. This provides the basis for the further development of the field and opportunities for collaboration between researchers (Kuhn, 1996).

The literature indicates that there are currently 20 distinct theoretical schools of economic thought in existence. Mainstream economics includes the classical school, neoclassical school, monetarism, rational expectations theory, real business cycle theory and Keynesianism. The conditions for including a school in mainstream economics include the use of deductive and inductive methods in research, analysing economic phenomena from a static and dynamic perspective, incorporating innovation in the models developed, developing a microeconomic basis for macroeconomic analysis, ensuring the internal consistency of the theory. Basic assumptions of the mainstream economics paradigm are as follows:

- we can only study economic reality with methodological individualism because economics describes the logic of human action;
- logic is universal and necessary and manifests itself in the actions of individuals considered independent of each other;
- economic rationality can be derived from economic individualism conceived in this way, which captures the second foundation of the mainstream economics paradigm, namely *homo oeconomicus* (Noga, 2013).

In the literature analysing the foundations of the mainstream school, it is unequivocally stated that the *homo oeconomicus* model (concept) enables the formulation of theoretical generalisations about the functioning of the economy as a whole. J. S. Mill was the first to recognise the model of the economic man, i.e. *homo oeconomicus*, as the fundamental assumption enabling scientific explanation in economics. Neoclassical economics introduces a theoretical, fictional economic individual (*homo oeconomicus*) into the analysis, who is characterised by the following features:

a) pursues a specific economic objective;
b) has knowledge – always full and proper – of the circumstances in which they are making a decision;
c) in order to realise their preferred goal, they perform the actions (select the means) suggested by their knowledge.

In our view, *homo oeconomicus* is the concept of an individual who is assumed to act rationally in such a way as to minimise unpleasantness or maximise pleasure. This task is solved by the individual making choices for the sake of an economic effect expressed in terms of value (profit, added value, utility).

If one were to put the concept of *homo oeconomicus* in scientific terms, one would have to cite John Stuart Mill, who created the model or, more to the point, the paradigm of *homo oeconomicus*. This point should be strongly emphasized: J.S. Mill did not have a **specific** individual in mind, but rather an **abstract**, **model** human being. There is no doubt that the concept of *homo oeconomicus* refers to Adam Smith's classical economics, which is essentially based on the value of the individual and their egoism. In fact, A. Smith argued that the choices of individuals are "governed" by animal instincts.

At this point, it is essential to conduct a thorough and rigorous analysis of the *homo oeconomicus* paradigm.

Firstly, John Stuart Mill (1806–1873), in developing the *homo oeconomicus* model, drew upon the research of Aristotle, J. B. Say, H. de Saint-Simon, J. Locke, I. Kant, A. Comte, and, of course, Adam Smith**.** At this point, we wish to strongly emphasise that this model speaks of **a hypothetical man** or **a fictional man** and not of **a specific man**.

Secondly, the *homo oeconomicus* model, as conceived by J.S. Mill, is based on certain assumptions such as: every human being is completely free in making their choices, is selfish, minimises unpleasantness or maximises pleasure, and is driven by "animal instincts" such as the instinct for self-preservation. Consequently, building macroeconomic models based on such a concept of *homo oeconomicus*, does not allow for the formulation of accurate, predictive conclusions and thus economics loses the possibility of applying the theoretical results of economic research, in economic practice.

Thirdly, the *homo oeconomicus* concept is criticised by sociologists and psychologists because it does not take into account the neurobiological and psychosocial aspects of human action, which are crucial in the economic decision-making process. In the *homo oeconomicus*

model, working individuals view the social environment as a **barrier** they must overcome to achieve their goals.

Fourthly, the *homo oeconomicus* paradigm also assumes free, free of charge access to information in the market, which is a purely model assumption, unrealistic in contemporary economic reality. This must be borne in mind when inferring from microeconomic and macroeconomic models published in the literature.

Fifthly, on the epistemological side, the *homo oeconomicus* model provided the theoretical basis for the study of economic reality using only **methodological individualism**. However, the modern economy is based on whole networks of interpersonal relationships and omitting them from economic research will delay or even prevent the discovery of objective economic laws. For these reasons, modern economics should also be based on methodological holism, in which rational economy will take into account the logic of choice of social groups and society in general (Noga, 2013).

The issue of interchangeability and the potential substitution of methodological individualism with methodological holism is sharply addressed in the literature. M. Blaug argues that orthodox methodological holism is the opposite of methodological individualism (Blaug, 1992).

In our opinion, methodological holism in the cognition of real economic reality can be used complementarily, not substitutionally, with methodological individualism. As an example of the symbiosis of methodological individualism with methodological holism in modern economics is the definition of economics, more precisely the object of economic research, proposed by P. A. Samuelson and W. D. Nordhaus. These two authors write that economics is the science of how **individuals and societies** decide on the use of scarce resources – which may also have other alternative uses – to produce various goods and distribute them for consumption, present or future, among various individuals and various groups in society.

The research field of economics presented above is an example of the complementarity of methodological holism with methodological individualism. Adopting such a position implies a change in the neoclassical paradigm of economics and, at the same time, allows for the complementarity of the described models of cognition of real economic reality.

Our discussion and analysis of the *homo oeconomicus* model outlined above leads to the following conclusions:

1. If we want to modify and not eliminate the paradigm of mainstream economics, we also need to modify the *homo oeconomicus* model.
2. A human being, living in the 21st century, most often makes decisions with limited time and knowledge, i.e. limited information, especially about the future.
3. In this situation, the concept of *homo oeconomicus* has become the subject of criticism by institutional economics, behavioural economics and neuroeconomics. For example, H. A. Simon replaced *homo oeconomicus* with the concept of *homo satisfaciendus*, i.e. a human being who makes choices on the basis of limited rationality and, unable to maximise his utility function, satisfies their needs only in a satisfactory manner.

A modern human being does not live in isolation, hence their decisions are always conditioned by the social environment.

Methodological holism shows that not only an individual, but also social groups or even the society as a whole can behave rationally. An example is the stock market, where, for example, one investor may behave irrationally, which does not mean that the stock market

behaves irrationally. The stock exchange as a team, a group of investors behaves rationally. This is how hundreds of thousands of group entities operate in the modern economy, and it is difficult to prove the thesis today that only an individual can behave rationally whereas a group cannot! The human brain first perceives fragments (points) of an observed object or phenomenon and therefore the image of the phenomenon as a whole is not immediately given. What is then needed is a synthetic linking of point perceptions of the phenomenon or object, i.e. a holistic view. Methodological individualism has "not outlived itself," but it is simply not enough to know economic reality, i.e. a complete perception of economic reality (Noga, 2024)

John F. Tomer lists six aspects of the mainstream economics paradigm:

1. *Narrowness* – narrowing the methods of analysis or the scope of the tasks, i.e. the research area.
2. *Rigidity* – involves a strong attachment to a particular research area and a lack of flexibility in adapting research methods to that area.
3. *Intolerance* – aversion to alternative research methods, move to reference research problems by other sciences.
4. *Mechanicalness* – the extent to which the behaviour of the entities under study is treated as mechanical and predetermined. Sciences that rank high on the mechanicalness scale use descriptions from mechanics, employing the metaphor of a machine and aiming for equilibrium as a desired state, much like neoclassical economics. In contrast, behavioural economics adopts a holistic, organic, and humanistic view, considering individuals in all their complexity within cultural, social, and historical contexts.
5. *Separateness* – the degree of separation between economics and related non-economic sciences, such as sociology, social psychology, and economic history. The greater the degree of interdisciplinarity, the less separate a scientific discipline is.
6. *Individualism* – and, in particular, methodological individualism, which derives all rationality from the behaviour of the individual, negating group, social and systemic rationality altogether (Tomer, 2007).

Viewed in this way, the paradigm of mainstream economics has not explained the causes of the recent global economic crisis, nor does it allow for predictive conclusions in the form of at least a warning forecast.

The first attempt to change this paradigm was to incorporate the results of ecological economics. This was because, in practice, it turned out that natural goods (natural capital) were scarce goods and not man-made goods. Attempts were therefore made to construct an alternative paradigm of economics, as was done, for example, by institutional economics. Constructing an alternative paradigm to the paradigm of mainstream economics has failed. This is especially true of institutional economics. Hence, the only way out was to modify the paradigm of mainstream economics. The recent global economic crisis has only confirmed that economics has serious prediction problems and therefore needs to "open up" not only to ecology, but also to psychology and all other strands of unorthodox economics.

The discussion of the mainstream economics paradigm so far has produced the following results:

- this paradigm should not be replaced by another paradigm but a modification of the paradigm of mainstream economics should be carried out;

- rigidly basing the paradigm of mainstream economics on methodological individualism results in the researcher being unable to describe economic reality, hence methodological holism should be used complementarily alongside methodological individualism;
- drawing a clear line of demarcation between the paradigm of mainstream economics and other sciences may highlight the perceived power of economics, but it fails to accurately describe economic reality. The excessive use of mathematical apparatus in economics is elegant, but does not capture all aspects of economics. Interdisciplinarity and the methodological "borrowing" from other sciences do not harm economics; on the contrary, they enable the better formulation of predictive conclusions;
- it would be naïve to think, for example, that experimental economics will create its own paradigm and supplant the paradigm of mainstream economics. On the other hand, it is a road to nowhere to disregard the results of experimental economics, for it is experimental economics that demonstrates that in economics the primacy of short time over long time does not provide the premises for modelling economic processes and constructing predictive conclusions. Medium and long time are the foundation of economic theory;
- economics is not able to produce deterministic economic laws as the natural sciences do. Economic laws are discovered and formulated as stochastic laws, akin to laws of large numbers.

Of course, modification of the paradigm of mainstream economics can take place in a variety of ways.

Firstly, it can be the use of different types of filters. The first one, in our opinion, was the ecological filter, applied by the Club of Rome in 1972. What this meant was that economic laws that had been discovered and formulated were "put through" the filter of ecology, in an attempt to answer the question: does the economic activity of man interfere with man's relations with the biosphere to such an extent that the biosphere may be destroyed and man will lose his natural environment and will no longer be able to live. At this point, we would like to emphasise that the essence and application of filters to modify the paradigm of mainstream economics, will allow for a precise description of economic reality, knowledge of the relevant relations occurring in this reality and, consequently, good forecasting and accurate economic decision-making at the microeconomic and macroeconomic levels. Such a modification of the paradigm of mainstream economics, has become possible today, as here we can use the "services" of artificial intelligence, which will be the subject of our reflections and analyses in the next part of this paper.

Secondly, other filters can also be added here, such as:

- cultures;
- biology;
- psychology;
- sociology;
- stories.

Thirdly, modification of the paradigm of mainstream economics must also change the assumptions about the rarity of goods in the economic process. What has become scarce today are goods of nature, which were previously called free, rather than man-made goods, which we can produce today in any quantity. Changing the paradigm assumptions of mainstream economics will change the paradigm itself.

Fourthly, the human brain is involved in the economic decision-making process. Millions or even billions of brain operations, in economic decision-making, may be characterised by a certain regularity, which can be expressed not only as trends or regularities but as laws of neuroscience, which, in combination with economic laws, will be the laws of neuroeconomics. This is the probability of the development of economic theory. Scientists did not arrive at this state of affairs immediately. First, the foundations of behavioural, evolutionary, and experimental economics were developed, and only later did neuroeconomics emerge. This process will also change the paradigm of mainstream economics, but not by abolishing it but by modifying it, with another biological filter (Noga, 2024).

3. ARTIFICIAL INTELLIGENCE – EMERGENCE, DEVELOPMENT AND APPLICATION IN MODIFYING THE PARADIGM OF MAINSTREAM ECONOMICS BY CREATING A RESEARCH FILTER

In 1955, J. McCarthy, M. L. Minsky, N. Rochester, and C. E. Shannon introduced the term 'artificial intelligence' to the literature (McCarthy et al., 2006). "Artificial intelligence is the branch of computer science that deals with the creation of programs and systems that can use tasks that require human intelligence." The usual acronym for artificial intelligence in the literature is AI.

> *By AI, therefore, is meant a technical solution (implicitly a computer program) that performs activities that are usually the domain of humans, especially those requiring the use of human intellect. AI is a machine that behaves like a human – a machine that thinks.*

In the scientific literature, there is no single definition of artificial intelligence that is universally accepted. Researchers try to create a universal definition of AI, but they are more interested in the application of AI than in a precise definition of AI. Of course, AI also has applications in the economy.

Despite the tremendous development of artificial intelligence and the commitment of huge resources to AI, there is still a whole series of intentions not realised:

(a) Creating a program that can effectively mimic human conversation is challenging. While there are programs, often called chatterboxes, that attempt to simulate conversation, it usually becomes apparent after a few minutes that one is interacting with a machine rather than a human.

The Turing test was simply not met, which involves considering a machine intelligent if a human tester is unable to distinguish between "the machine's responses and a human's responses."

(b) Machines based on AI programs have not yet created a project that can effectively generate profit by trading in the stock market.

(c) AI has not yet created a program to translate literary texts and colloquial speech. The main difficulty here is the complexity and vagueness of natural languages and, in particular, the program's failure to understand the meaning of the text.

For the sake of analysis, let us add that artificial intelligence includes:

– Evolutionary Algorithms – EA;

– Expert systems (interpretive, predictive, diagnostic, completion, planning, monitoring, control, correction, repair and instruction) ;
– Artificial neural networks, which are used for contextual and invariant recognition, classification tasks, image analysis and image processing. They are also used in economics, creating a new economic science – neuroeconomics;
– Fuzzy logic (McCarthy et al., 2006).

Economics as a science must not only be epistemological, but, above all, cognitive. If economics as a science does not formulate predictive conclusions, recommendations, solutions, it will cease to be a science and become a mere scientific reflection. Moreover, the conclusions must be pertinent in the sense that they will realise the goals of economics on both the microeconomic and macroeconomic scales. This is very difficult because economic laws are stochastic and will never be deterministic. **Artificial intelligence is not able to convert stochastic economic laws into deterministic economic ones.** Therefore, artificial intelligence should be used to study economic reality in such a way that accurate economic decisions can be made. This does not mean that our decisions will be 100% correct, as that is the nature of economic processes.

Members of households, firms, institutions, public bodies at all levels, make economic decisions to solve a specific problem, i.e. to achieve a well-defined goal. Using the classical paradigm of mainstream economics, we will achieve the goal only to a suboptimal, or unsatisfactory, degree. Applying a specific scientific filter [at the input] within the paradigm of mainstream economics will result in achieving an optimal outcome [at the output]. In this context, data filtering is frequently discussed in the literature, and artificial intelligence is ideally suited for this task. Data filtering involves selecting or not selecting specific information from a dataset based on a set of criteria. This is important for finding important data, removing unnecessary information and improving the overall quality of the data.

Analysing data is about finding unusual values by examining filtered data to make sure the results are accurate and reliable. Whether you are working with large datasets in analysis, databases or with day-to-day tasks, good filtering can increase the efficiency of your workflows.

At this point, it should be noted that the literature uses the term 'filter' as follows, as:

1. A partition or device used to separate solids from liquids or gases;
2. A device that absorbs, reduces or scatters part of the light or sound waves passing through it;
3. A substance that protects the skin from the sun's harmful rays;
4. A computer program that performs a selection or simple transformation of input and/or output data.

Our analysis, carried out in this paper, allows us to define the concept of a 'filter' as a research program of economic science that consists of selecting or not selecting data in the process of studying economic reality, based on a set of adopted criteria, allowing the science of economics to formulate predictive conclusions, in an optimal way, characteristic of stochastic economic laws.

Data filtering involves selecting and displaying a subset of data based on specific criteria. The method of data filtering can vary depending on the 'slice' of economic reality we want to learn about, its cultural, historical, natural, biological, institutional context, or from the point of view of the decision we have to make to solve a scientific problem of great applied importance.

When filtering the data, attention should be paid to temporal aspects. You need to identify precisely the relevant time periods for your analysis in order to obtain accurate and meaningful information, e.g. for further research on the one hand and for economic decision-making in practice on the other. Researchers often sift through large amounts of data to find information relevant to their research. Data filtering simplifies this process and allows researchers to focus on specific data points relevant to their research goals. Artificial intelligence can play a dominant role here. Furthermore, if we apply multiple filters simultaneously, including *eo ipso* filtering, we can study economic reality in an optimal way. This approach will facilitate rational economic decision-making and also influence the development of economic science.

4. COMPLETION

Our research carried out in this study by means of comparative analysis, inductive, deductive and reductive reasoning on how the paradigm of mainstream economics operates in economic theory and in economic practice allows us to draw the following conclusions:

- Economics as a science must not only be epistemological, but first and foremost a cognitive science, i.e. it should formulate predictive conclusions with an applied meaning.
- Economic laws are stochastic and based on the laws of large numbers. Neither the digitalisation of decision-making processes and economic processes nor the development of artificial intelligence can convert these stochastic economic laws into deterministic economic ones.
- Hence, the paradigm of mainstream economics remains in place. However, it should be modified in such a way that, in the process of researching economic reality and its environment, specific filters should be applied at the input and output, precisely described in this paper, in order to achieve the intended social and economic goals, ensuring the symbiosis of Man with the biosphere, intergenerational justice and the improvement of individual and social welfare. The classical approach within the mainstream economics paradigm failed to achieve its goals because it was unable to accurately describe economic reality or formulate precise predictive conclusions needed to achieve those goals. Today, thanks to artificial intelligence, it is possible to formulate accurate predictive conclusions regarding socio-economic development, although economic actions are still subject to economic risk and will never be certain events with a probability of 100%.

The main thesis and objective of this paper – arguing that the paradigm of mainstream economics should not be abolished but rather modified as we have outlined – has been supported by the principles of formal and classical logic.

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