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A CURRENT PERSPECTIVE ON THE RELATIONSHIP BETWEEN ECONOMICS AND PHYSICS

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Anatation: If we recognize that the foundations of modern economics were laid by Adam Smith's famous work "The Wealth of Nations", we see that economics has been in interaction with other sciences for almost two and a half centuries. Within these sciences, the place of physics is undoubtedly several steps ahead of the others. In the process of this interaction, economic theory has also been influenced by paradigm shifts in physics and has developed in a continuous evolution. By the end of the twentieth century, the concept of econophysics emerged, as statistical physics was mainly used by various scientists to understand economic phenomena. This article discusses the relationship between econophysics and the field of economics, especially financial economics. Why econophysics is considered a different science is explained based on the working methods and assumptions of both scientists.

Keywords: Econophysics, Economics, Financial Economics, Physics

Login. The science of economics has undergone many changes and developments over the two and a half centuries since it was established in its modern form with Adam Smith's famous work The Wealth of Nations (1776). During these paradigm shifts, debates, and compromises, the relationship of economics, a social science, with other disciplines has also changed, with some periods when it was more closely associated with other social sciences, while others when it was more closely associated with the physical sciences. The interaction between economics and the physical sciences is perhaps one of the most decisive factors in the development or transformation of economics into a science.

Throughout the development from classical to neoclassical, economists have been inspired by the conceptual and mathematical developments of the physical sciences and their remarkable success in describing and predicting natural phenomena. Adam Smith was undoubtedly influenced by the work of Newton, the founder of classical physics. The sophistication that Newton's laws of motion brought to physics was something that other scientists of the time also imitated for their own fields. In the process of scientificizing economics, given the imitation of the position of physics in the physical sciences, it moves to the use of mathematics for this purpose, Classical economics with Newtonian physics and Euclidean geometry, Neoclassical economics with thermodynamics and differential calculus, Einsteinian physics and Riemannian geometry and Keynesian economics, quantum physics and topology. The relationship of general equilibrium economics is also important for understanding the interactions of today.

The direction of this interaction has been mainly from physics to economics. One reason for this is that it has the most advanced computational methods among the sciences, in addition to the theoretical approaches of physics. However, there are also important names who studied physics and contributed to economics. Alphonse Quetelet (1796-1874), Léon Walras (1834-1910),

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Vilfredo Pareto (1848-1923) and Robert Gibrat (1904-1980) all had training in physics or engineering and contributed to economics.

There are many differences between the methods of studying natural sciences and social sciences, examining phenomena and testing their hypotheses. Despite the problems of science suitable for experimentation and replication, social sciences are mainly concerned with people and social structures created by people, which are inherently variable. This article reviews the past and present state of the interaction between the natural sciences, physics and economics from the social sciences, and introduces the relatively new concept of econophysics and the debates surrounding this concept.

Economics and physics

If the 18th century is considered the century in which the foundations of economics were laid, then it can be said that the interaction between these two disciplines began in this century. In Adam Smith's laws of supply and demand, traces of Newton's laws of motion, especially the third law, which states that every action creates a reaction, can be seen. Early economists tried to view the economic system as a mechanical system and to base their analysis on it in the same way as physicists or engineers. The only difference, it can be said, is that in science experiments form the basis of theories, while in economics observations perform the same function. In the late 19th century, Francis Edgeworth and Alfred Marshall, inspired by some of the ideas of physicists, proposed that the economy should be in equilibrium, just as Clerk Maxwell and Ludwig Boltzmann had proposed for gases.

This interaction was also evident in the early 20th century. In his attempts to model the movement of stocks and bonds on the Paris Stock Exchange, mathematician Louis Bachelier developed the mathematical theory of diffusion, and shortly thereafter Albert Einstein proposed the theory of Brownian motion, based on the same diffusion equation. Einstein's theory, whose contribution to quantum physics cannot be denied, is one of the main theories used in financial economics, especially in the field of stock price movements.

Criticisms and Impact of the New Physics

It seems that throughout history, economists have generally imitated the scientific power of physics in the natural sciences, but have not been willing to follow the changes that physics has undergone in the 20th century. It can be said that since the beginning of the 20th century, both physics and other natural sciences have undergone paradigm shifts. The work of Einstein and others, the theory of relativity, and the birth of quantum physics have brought many innovations. Established theories in physics and, later, in natural sciences such as chemistry and biology have been questioned . Economics has not been sufficiently affected by this change compared to previous experiments. Theoretically consistent and justified mathematical models have not been sufficient to explain the facts due to the limited assumptions on which they are based. While the natural sciences have focused on cases of deviation from equilibrium, economists still continue to conduct equilibrium analysis, in which a perfectly knowledgeable, rational, and impartial homo economicus acts and dynamic behavior is considered external. One important example of

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this is the general equilibrium paradigm.

The general equilibrium paradigm of Leon Walras, one of the representatives of the neoclassical movement, parallels 19th-century physics in almost every respect. Walras has been widely criticized in his work, claiming that he misconstrued the mechanics of his theory or misunderstood the mathematics. Mirovsky's findings that neoclassical economics takes developments and basic elements from physics and introduces them into economics, and therefore has blind spots, are among the most important criticisms leveled against neoclassical economics, along with quantum mechanics. Although Mirovsky's theses have been criticized and some mathematical errors have been identified in his findings, Mirovsky has made a significant intellectual contribution to economics. At this point, it is safe to say that it is clear that ideas, desires, or thoughts cannot influence events as physics changes dimensions with quantum mechanics.

The concepts of uncertainty and complexity began to gain importance. The approaches of physicists and economists in analyzing these concepts differ significantly. In today's economic approach, uncertainty is ignored and this gap is attempted to be filled by the concepts of risk and expected return. The quantum revolution in physics ended the deterministic approach brought by Newton's classical concept. An example of this is Heisenberg, who in 1927 proposed the idea that the position and velocity of a particle cannot be determined simultaneously. While physics involves uncertainty, especially at the micro level, the search for certainty in economics continued.

A new approach to economics

The field of econophysics is a field that emerged as an attempt to explain certain issues in economics, especially finance, mainly using statistical physics. Although some schools of thought have emerged in this field since its inception, the most influential among them is undoubtedly the Boston School. Of course, this is due to the fact that the physicist Eugene Stanley, who introduced the concept at a conference in Calcutta in 1995, was in the physics department of this university. Although it is still a new field of science, statistical physics, especially its efforts to explain financial phenomena, is increasingly attracting the attention of physicists. So what motivates physicists to study the social sciences? Physics is concrete and specific, and draws its predictive power from certain universal truths; however, the question arises whether there are any such truths in the social sciences. Given the complexity of the human world, is there any information that can explain this? A pioneering paper on this topic was written by Majorana. This paper establishes the connection between statistics in the physical and social sciences and draws attention to the similarities. It was first noted that there are important similarities in two very different disciplines. One of the most important similarities is that both disciplines look at things from different perspectives.

Rohner responds to criticisms about why physics should have a say in the social sciences by saying that physics contributes to the social sciences by providing experimental methodology. The experience of physicists, especially statistical physicists, with working with data is undeniable. Given the large amount of data available in economics, especially finance, the

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existence of various distributional properties and power laws governing this data and their possible consequences can be included among the main areas of interest of econophysics. The impact of increasing computers and computing power on the development of data-driven methods is also very important.

Nowadays, with computers capable of processing large amounts of data and simulating stochastic processes, there is no need to strive for simplicity, no matter how complex. Economic systems are complex systems that interact with each other and contain a large amount of numerical data (much of which has never been examined). The study of the statistical properties of this data has long attracted the attention of scientists. The distributional differences of financial time series were first revealed by the mathematician Mandelbrot. It was observed that the returns of the stock market index do not fit the normal distribution (Gaussian), but show fat-tailed behavior. However, stylized effects such as volatility clustering and leverage effects have also been observed in various studies. The failure of economic theory to explain empirically observed non-Gaussian distributions led to the emergence of an econophysical approach. The distributional properties of financial time series remain a major topic of econophysics. According to Richards, one of the greatest contributions of econophysics to the literature was to show that financial time series have fractal properties.

Breakdown points

The relationship between econophysics and economics has not strengthened in the last 15 years, but rather has widened. The lack of methodological consensus may be due to the widening gap. In mainstream economics, economic phenomena are modeled by working with a priori models. The basis of this approach is that the importance of data is not taken into account. Econophysics, on the other hand, starts with data and moves away from the basic model approach. In this regard, they often ignore the assumptions of mainstream economists. In reality, these assumptions are not met, especially in complex areas such as finance, which leads to weak explanatory power of the models. Economic assumptions are aimed at simplifying real situations. But physicists do not have such an aim. They try to understand real situations through images. As Shinkkus argues, economics, criticized for being sterilized and simplified by various axioms, is not even a science in this sense. He also argues that econophysics, which rejects mainstream economics with some of its views, is not a new approach, but a new science.

Conclusion. Economics has developed in collaboration with many disciplines since the 18th century and has taken its current form. Among the disciplines with which it collaborates, physics occupies a distinct position. The 18th-century economics, based on physics and the laws of motion, was transformed in the 20th century by the rise of quantum physics. Along with physicists, economists also contributed to this change. In particular, criticism of neoclassical economics contributed greatly to the development of economics. With this development, different views emerged in economics. The most important of these are financial economics, which uses quantum physics without departing from the basic principles of economics, and econophysics, which uses similar methods but puts forward the idea that all foundations should be created with knowledge obtained through experiments. This article discusses the approaches of economics and econophysics to economic phenomena and how they differ from each other.

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The main difference seems to be that economists take a data-driven approach, while economists try to draw conclusions based on certain assumptions . This is why the literature has begun to see econophysics as a separate discipline.

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