Management Studies, Sep.-Oct. 2024, Vol. 12, No. 5, 339-342
doi: 10.17265/2328-2185/2024.05.011

Beyond Equations: The Challenge of Mathematical Rigor in Economics

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> The mathematical approach is threatening the progress of economics, as it tends to disregard the complexity of economic behaviour and the unpredictability of human actions.
>
> —Friedrich Hayek

The reliance on mathematical models in economics has long been debated, with critics arguing that this approach fails to capture the complexity of human behavior and the unpredictability of economic systems. While mathematics provides a structured method for analyzing economic processes, it often simplifies decision-making to a one-dimensional utility function, neglecting social, psychological, and political influences. This paper examines the limitations of classical and neoclassical economic theories that heavily depend on mathematical rigor, highlighting the pitfalls of models like the Rational Agent Model, General Equilibrium Theory, and Expected Utility Theory. Drawing on examples such as the 2008 financial crisis and the Terra/Luna cryptocurrency collapse, the paper demonstrates how over-reliance on equations has led to inaccurate predictions and ineffective policy decisions. It calls for a more interdisciplinary approach that integrates insights from psychology and sociology to address the gaps left by traditional mathematical economics.

Keywords: classical economics, mathematical, economics

Rethinking Economic Models: The Pitfalls of Mathematical Formalism

Classical economics has been associated with mathematics as one of the branches of science that employ number systems in handling natural science knowledge. However, this working strategy is often ineffective due to the need for more consideration of social factors and counterintuitive actions of people. Thus, by considering decision-making and its output as a simple numerical value, it proposes a way of thinking that is not just anti-human but anti-good and anti-bad.

Many scholars agree that that the fundamental motivations of economists are well-intentioned: they try to minimise the application of biases and, hence, attempt to start approaching the field of economics through the aid of mathematical equations or propositions in the form of theorems. However, there is a fundamental difference between mathematics and economics: the former is defined with very clear lines of demarcation and complete detachment, and the latter tries to place mathematics among the tools we employ to describe economic activities with the greatest degree of accuracy. In his book *Foundations of Economic Analysis*, Paul Samuelson (1947)

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posited that although the economic model yields relative certainty in depicting the market structures and resource distribution, it needs to be more accurate in tackling individual behavioural issues.

Human Behavior vs. Mathematical Equations: The Complexity of Economic Decision-Making

Neoclassical economics theories state that social members undertake economic activities for maximum utility. This applies to the Rational Agent Model, which establishes the relativity of causes and effects of human actions and economic impacts. Neoclassical economics theories assert that social members engage in economic activities for maximum utility, supported by the rational agent model, demonstrating causality between human actions and economic outcomes. However, real life experience tends to deny the assumption economists make in most instances. For instance, Daniel Kahneman and Amos Tversky (1979) have contributed significantly towards the development of behavioural economics by proving that people's decisions are indeed inclined by biases in reasoning and emotionally charged self-booking behaviours. As other examples, one can refer to such real-life events as the Terra/Luna crypto crash in 2022 that prove the instability and unpredictability of the economic market. This event was accompanied by a panic selling spree in UST and Luna tokens occasioned by the unpredicted loss of confidence. It also caused investors to rush to sell their stakes, thus decreasing prices and, ultimately, causing the failure of the algorithmic stabilisation tools. This case also underlines the danger of relying solely on the analytic reconstructions of the process and dynamics of economic activities that are variable between and within the states and constantly alternating between order and chaos, reason and irrationality. Further, mathematical models prove inconsistent in making accurate judgments, and none of them can update and recalculate under conditions of consumer stress or diminishing market confidence (Smith, 2023).

Mathematics in Economics: When Rigor Overshadows Reality

Besides, the funds are also ideally shaped, which does not portray the real world as it is, while economists' "bricks" are valueless in having an ideal model that mathematicians cultivate. The same inconsistency is also contemplated in the General Equilibrium Theory, done by Leon Walras and further developed by Kenneth Arrow. The theory emphasises the set goals of bringing balance within the markets with the help of mathematical figures (Walras, 1874; Arrow, 1951). This is done so that a proper result can be provided in the issues of economics, assuming circumstances such as perfect competition and complete information. However, such conditions are scarcely practised in real-life markets. It leads to inefficiency in policy recommendations due to a lack of consideration of several factors and conditions that exist in the economy. For example, the adversity experienced in the 2008 financial crisis was partly attributed to over-reliance on inferior mathematical techniques that considered measures of risk and wholly discounted other important elements of the risks, such as the systems risk and complete exclusion of psychological factors (Reinhart & Rogoff, 2009).

Also, the mechanical models used in economic analysis are deterministic; the randomness of the financial processes is thus not accounted for. In general, contemporary macroeconomic models named Dynamic Stochastic General Equilibrium (DSGE) include expectation and shock in their models. A typical DSGE model equation looks like this:

$$E_t[F\{y_{t+1}, y_t, y_{t-1}, x_t, \ \theta)] = 0$$

Economics and its components are defined in equations, although they are contingent upon hypotheses relative to agents' behaviour and the market. The mathematical solutions are not adequate in dealing with financial bubbles and crashes, as reluctance to rely on instinct factors and social influences distorts personal sentiments and brings inaccuracy to the preferences of the bias of the economic formulas.

The Expected Utility Theory, which underlies most economic descriptions of decision-making under risk, is an example of the problems of mathematisation. The Expected Utility Theory is expressed mathematically as:

$$E[\mathrm{U}(x)] = \sum_{\mathrm{i}} p_{\mathrm{i}}\, \mathrm{U}(x_i)$$

This theory reduces the choice to a one-dimensional utility function. For this reason, inevitable neglect of a remarkable aspect of human preferences, which are fundamentally multidimensional, takes place (von Neumann & Morgenstern, 1944). Real-world decisions are always compromising in nature; one factor is traded off for another, such as risk, time preference, or social pressure. In addition, behavioural economists have demonstrated that in everyday life decisions, individuals are often risk-averse and loss-averse, contrary to what has been described in EUT by Tversky and Kahneman (1992). These lapses from rationality pose problems for the theories that do not allow psychological and social factors.

Mathematics helps give a more rigorous form to theories and obtain solutions to various problems; it must be remembered that this is only a part of the overall economic research. Different approaches' incorporation can deepen the vision of the financial processes if a certain focus has been put on the mathematical formalisation of the essence. For example, behavioural finance has been developed as an offshoot of traditional finance after the failure of this branch to explain the oddities of the market (Thaler, 1993). With input from the sphere of psychology, this approach provides additional perspectives to the analysis of the markets and the decisions made by investors.

Policy consequences, too, are limited by the mathematical models used in defining and analysing economic activity. Policymakers commonly apply these models to assist in choosing monetary and fiscal policies. Even with the basic setup of many models, the generated policies can be either malicious or completely ineffective. For example, the European sovereign debt crisis was aggravated by adopting austerity policies stemming from thought experiments that ignored the characteristics and conditions of the respective SOEs (Blyth, 2013).

Due to education and economic positivism, the ability to critically evaluate models is short, which results in a lack of insight into social processes. Indicated prejudice is among students, limiting their response toward world economics. The disciplines employed in modern economic analysis should include psychological, sociological, and political.

While integrating theories and experiences utilisation, psychological, sociological, and political science approaches should be involved in the contemporary and vocational analysis of the economy. Mathematics cannot formalise abstract economic actions, and economics should be used and constituted as a research and application science using both mathematical and other methods.

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