The Mathematization of Economics: Useful, Inevitable, Indispensable or Simply Extravaganza

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Received: Dec 28, 2020; Accepted: Jan 25, 2021

CITATION: Moosa I. 2021. The Mathematization of Economics: Useful, Inevitable, Indispensable or Simply Extravaganza. Management and Economics Research Journal, 7(1): 1-4, Article ID 9900037. DOI: 10.18639/MERJ.2021.9900037

1. INTRODUCTION

For those who (wrongly) believe that economics is a science, just like physics is a science, the mathematization of economics is inevitable and indispensable, since mathematics is the language of science. Thus, the development of mathematical economics is only natural. Mathematical economics has its roots in the works of classical economists such as W.S. Jevons, Carl Menger, and Leon Walras. Irving Fisher (1892) described Jevons' book, *A General Mathematical Theory of Political Economy*, as the start point of mathematical economics.

While the use of mathematics can be useful for the exposition of economic theory, the mathematization of economics has been taken too far, to the extent that the means has become an end in itself. The objective of this note is to argue that the excessive mathematization of economics is not necessary and that while a small dose of calculus can be useful, most of the contemporary mathematical representation of economic theory is simply extravaganza.

2. THE EVOLUTION OF MATHEMATICAL ECONOMICS

Debreu (1991) marks 1944 as a sharp turning point in the history of mathematical economics and the beginning of a period of explosive growth in the mathematization of economics. His measure is the number of pages published in *Econometrica*, *Review of Economic Studies*, *International Economic Review*, *Journal of Economic Theory*, and *Journal of Mathematical Economics*. In 1977 these five journals together published over 5,000 pages. During the period 1944-77, the number of pages more than doubled every nine years. The year 1944 was significant for the development of mathematical economics also because it was the year when John von Neumann and Oskar Morgenstern published a landmark study in mathematical economics, *The Theory of Games and Economic Behavior,* in which they applied topological fixed-point theory to economic analysis.

The rapid growth of mathematical economics is not reflected in the number of pages in those five journals only, as even mainstream journals started to publish abstract mathematical papers, or at least papers that use equations and mathematical analysis. Take, for example, the *American Economic Review*: in 1940 less than 3% of the pages of volume 30 included rudimentary mathematical expressions, but 50 years later nearly 40% of the pages of volume 80 displayed sophisticated mathematics. Sutter and Pjesky (2007) examine papers published in 2003 and 2004 to measure the extent of mathematics-free research in top economics journals. Of more than 1200 papers published in ten top journals, 6% met a weak criterion of mathematics-free, 3% met an intermediate criterion, and only 1.5% met a strong criterion. They reached the conclusion that if Adam Smith were alive today, he would need to learn mathematics to survive despite his mastery of the literature, history, and ethics. No Adam Smith of the present time can publish in top journals where importance and contribution to knowledge are measured in terms of the extent of using mathematical analysis.

In the post-war period, Paul Samuelson took the lead in applying mathematics to economics. Samuelson (1947) insisted that mathematics was essential to the understanding of economics. Earlier, JM Keynes (1936) had criticized the use of mathematics in economics by suggesting that "too large a proportion of recent 'mathematical' economics are merely concoctions, as imprecise as the initial assumptions they rest on, which allow the author to lose sight of the complexities and interdependencies of the real world in a maze of pretentious and unhelpful symbols". In response, Samuelson (1952) argued that the language of mathematics is sometimes necessary for representing substantive problems and that mathematical economics has led to conceptual advances in economics. Likewise, Robert Solow (1988) concluded that mathematical economics was the core "infrastructure" of contemporary economics, arguing sarcastically that "economics is no longer a fit conversation piece for ladies and gentlemen" because "it has become a technical subject". Solow believed that any economist who could not handle sophisticated mathematics is either a "lady" or a "gentleman"

It seems that Samuelson and Solow won the argument, changing economics as we see it in the writings of Adam Smith, Karl Marx, and JK Keynes to what we see in major journals these days. Moosa (2017) presents two equations, one taken from *Econometrica* and the other from the *Journal of Experimental and Theoretical Physics*. It is challenging to tell which is which, even though the *Econometrica* equation is supposed to be a description of the economy with all of its human interactions whereas the other equation describes a natural phenomenon governed by the laws of physics. Nowadays, a typical page of *Econometrica* is indistinguishable from a typical page in a journal of physics or even pure mathematics. This is why a joke goes as follows: in Nicolae Ceausescu's Romania, all "Western" economics journals were banned, except *Econometrica* because it had nothing to do with economics (or with econometrics for that matter).

3. THE VIEW OF CONTEMPORARY ECONOMISTS

The excessive mathematization of economics is resented by most contemporary economists, including those who are acquainted with sophisticated mathematics. Blommestein (2009) suggests that the mathematization of economics has led to a new form of "mental gymnastics" of a "peculiarly depraved" type. David Hendry, who knows his mathematics rather well, declared in an interview with *Econometric Theory* in 2004 that "many American economists now rely heavily on abstract economic reasoning, often ignoring institutional aspects and inter-agent heterogeneity, as well as inherent conflicts of interest between agents (Hendry, 2004). One "advantage" of using sophisticated mathematics in economics is that it is impossible for the average reader to detect flaws in the analysis—hence those "economists" who rely heavily on mathematics hide behind a strong shield.

Velupillai (2005) argues that "the headlong rush with which economists have equipped themselves with a half-baked knowledge of mathematical traditions has led to an un-natural mathematical economics and a non-numerical economic theory". He suggests that mathematical economics is unreasonably ineffective because the underlying assumptions are economically unwarranted and because the mathematical formalizations imply non-constructive and incomputable structures.

In response, Focardi and Fabbozi (2010) admit that "economic science is generally considered less viable than the physical sciences", and that "sophisticated mathematical models of the economy have been developed but their accuracy is questionable to the point that the [2007–08] economic crisis is often blamed on an unwarranted faith in faulty mathematical models". Nevertheless, they claim that "the mathematical handling of economics has actually been reasonably successful and that models are not the cause behind the present crisis". On the one hand, they admit that "the science of economics does not study immutable laws of nature but the complex human artefacts…that are designed to be largely uncertain.... and therefore, models can only be moderately accurate". On the other hand, they boast that "our mathematical models offer a valuable design tool to engineer our economic systems". The response to the claims made by Focardi and Fabbozi (2010) is easy. To start with, there is no such thing as "economic science" or "science of economics". They do not tell us in what sense "the mathematical handling of economics has actually been reasonably successful" and how "mathematical models offer a valuable design tool to engineer our economic systems". These claims cannot be valid, given that we have been moving from one crisis to another. The use of sophisticated (but unrealistic) mathematical models typically leads to complacency and faulty policy prescriptions that contribute significantly to the advent of crises.

The fact of the matter is that the mathematization of economics was driven by the desire to make economics as "sciency" like physics. In his brilliant book, *Two Centuries of Parasitic Economics*, Basil Al-Nakeeb (2016) reminds us of "another grim problem facing macroeconomics", which is "an unwarranted mathematical complexity that ignores Leonardo da Vinci's wise advice: simplicity is the ultimate sophistication". He goes on to suggest that "complexity has been the fashion for some time", suggesting that "its practitioners are typically the first to get lost in the intricate math they weave, arriving at wrong conclusions and misguided policy recommendations". Mathematical economists fail to observe what Al-Nakeeb calls "two universal tests for any fruitful endeavor: relevance and common sense". He reminds us of what Keynes said about "good or even competent economists", who are "the rarest of birds".

4. ARGUMENTS FOR THE USE OF MATHEMATICS IN ECONOMICS

Three arguments can be made to justify the use of mathematics in economics: first, mathematics is useful; second, mathematics is useful for studying economics; and third, mathematics is more useful than any other discipline for the use of economists. No one can dispute the first point that mathematics is useful—this is an understatement because mathematics is the language of science. If it was not for mathematics, we would still be riding camels and horses, because the invention of the internal combustion engine without mathematics would have been impossible. Technology has progressed by operationalizing the heavily mathematical principles of physics. However, economics is not physics, it is not science, and it is not technology—but this does not mean that economics is useless and that we should abandon the discipline as a branch of human knowledge.

As for the second point, mathematics is useful for studying economics, but this is true only to a limited extent and so far, as using it as a tool. For example, simple differential calculus makes it easier to understand why the profit maximization condition is the equality of marginal cost and marginal revenue. In fact, the concept of "marginal" has an interpretation as it is the first derivative of the corresponding total function. Romer (2015) argues that mathematics can help economists clarify their thinking and reasoning. However, the ubiquity of mathematical theory in economics also has serious downsides: it creates a high barrier to entry for those who want to participate in the professional dialogue, and makes checking someone's work excessively laborious, if at all possible.

The third point that mathematics is more useful than any other discipline for the study of economics implies that anyone who knows mathematics and nothing about economics is a better economist than someone who knows economics but not mathematics. A contemporary economist who uses mathematical expressions to describe his ideas must be a better economist than Adam Smith, Karl Marx, JM Keynes, and Joan Robinson. The problem is that belief in the third point has been reflected in the design of curriculum in graduate programs in North America in particular. A PhD program that requires a year of calculus neglects history, sociology, logic, and philosophy. The claim that mathematics is more useful than any other discipline for the study of economics is false because economics is a social science that would benefit more from the incorporation of psychology, sociology, and law than mathematics. It is this very belief that is impeding the development of economics in the direction of producing improved policy recommendations.

It is rather perplexing that the belief, that a good economist should have a greater knowledge of mathematics than any other discipline, is still widespread in the aftermath of the global financial crisis. Lawson (2015) suggests that many economists use mathematical methods just because this is what is required of them, not because of any deep belief in their relevance or utility and that those with power allow almost no leeway for the undertaking of alternative approaches and act as very restrictive gatekeepers. From an academic perspective, the opportunity cost of the mathematization of economics is the neglect of other relevant disciplines. In an interview with Levinovitz (2016), Paul Romer said the following: "Somebody came and said: Look, I have this Earth-changing insight about economics, but the only way I can express it is by making use of the quirks of the Latin language". In response, Romer believes, "we'd say go to hell unless they could convince us it was essential".

5. RAMIFICATIONS OF THE MATHEMATIZATION OF ECONOMICS

The mathematization of economics has had some ramifications, some of which are detrimental to the progress of economics, both as an academic discipline and as the framework of analysis used to formulate public policy. Mathematical analysis is supposed to be a tool that helps understand economics and economies. However, what has happened as a result of the mathematization of economics is that theory is twisted to fit a mathematical framework, including the use of unrealistic assumptions. For example, the assumption of profit maximization is used in microeconomics because it makes the underlying issue more suitable for differential calculus. Mathematical economists confine themselves to their offices and theorize about how firms make their production and pricing decisions rather than simply asking firms what they actually do. They model the behavior of banks without asking bankers how they make their decisions. In macroeconomics, the unrealistic assumption of wage and price flexibility is used, in conjunction with the rational expectations' hypothesis, to prove (mathematically, of course) that government intervention in the economy is destabilizing at best and hazardous at worst (for example, Lucas and Sargent, 1981; Sargent and Wallace, 1976). This is what a "business-friendly" government likes to hear.

Another consequence of the mathematization of economics is that the discipline has become increasingly irrelevant to policymakers because mathematical models do not address policy problems directly, because policymakers cannot comprehend the models, and because mathematical economists cannot translate equations into words—hence they cannot transmit their findings to policymakers. Furthermore, mathematical models are used to justify policies that have been pre-determined by politicians on ideological grounds. In this case, complexity is useful because the public can be told that a brilliant economist has worked out that this is the best policy action. For example, the Efficient Market Hypothesis (EMH) was developed to justify financial deregulation. Fox (2009) suggests that those writing in the spirit of the efficient market hypothesis "sealed off in their academic cocoons" to write papers in their mathematical jargon—as a result "they developed an internal logic quite divorced from market realities".

The mathematization of economics has led to a downgrading of academic economics in more than one way. The trend has created barriers to entry in the profession, depriving the discipline of people with different perspectives who can contribute significantly by bringing in different insights. On the other hand, some brilliant economists have left the field and moved to other disciplines because they cannot read the literature or publish in leading journals. Currently, the profession has a class structure whereby those who sit on the top are those who know enough mathematics to be able to publish in *Econometrica*. Economists from different classes cannot even communicate. Furthermore, the mathematization of economics has inflicted damage on other disciplines through a process of brain drain, by attracting people from physics, mathematics, and engineering. Humanity would benefit more from a brilliant engineer working on a new generation of the internal combustion engine than formulating a model for trading in the stock market, which invariably does not work.

6. CONCLUDING REMARKS

Let us recall the wisdom of a great economist, Alfred Marshal, who gave the following advice about the use of mathematics in economics (Sills and Merton, 2000). The advice can be summarised in six points:

1. Use mathematics as a shorthand language, rather than an engine of inquiry.
2. Keep to them till you have done.
3. Translate into English.
4. Illustrate by examples that are important in real life.
5. Burn the mathematics.
6. If you can't succeed in (4), burn (3).

In 2009, Paul Krugman commented in *The New York Times* with a version of the "mathiness diagnosis": "As I see it, the economics profession went astray because economists, as a group, mistook beauty, clad in impressive-looking mathematics, for truth". Krugman (2009) believes that the desire of economists to show off their mathematical prowess is the "central cause of the profession's failure". It is essentially an inferiority complex vis-à-vis physicists.

One has to reach the conclusion that the mathematization of economics is useful if used moderately. It is neither inevitable nor indispensable. When mathematics is used excessively and becomes the end rather than a means to an end, it becomes some sort of extravaganza that can be lethal. The benefit of using mathematics in economics should be judged in terms of the contribution to our understanding of the working of economies and financial markets. Well, the contribution has been zero at best.

CONFLICT OF INTEREST

None.

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