EFFECTS OF MATHEMATICS IN ECONOMICS

T U Hewage

Sri Lanka Journal of
Economic Research
Volume 8(1) December 2020
SLJER 08.01.P: pp. 153-161
Sri Lanka Forum of
University Economists
DOI: http://doi.org/10.4038/sljer.v8i1.129

INTRODUCTION

Usage of Mathematics in Economics, to a certain extent of course, is both unavoidable and necessary. But, whether there is too much mathematics in the discipline of "Economics" has been an age-old debate, that can be traced all the way back to 1800s where French mathematicians/economists/philosophers such as Nicolas-Francois Canard (1754-1833) and Antoine Augustin Cournot (1801-1877) were trying to introduce mathematical analysis to explain certain procedures in economic theories.[2][4]

Usage of mathematical skills in their attempts of dealing with economic concept such as taxation, supply and demand and pricing and value was not received well by the classical economists at the time. Even though Cournot's oligopoly concept was not given due consideration in 1838 when it was first introduced, the extended work of this theory by John Nash to introduce "Nash Equilibrium" was recognized with the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1994.

One interesting observation in the evolution of "Economics" as an interdependent discipline is its association with mathematics, through the 19th and 20th centuries, as a mode of explanation, while being accused of losing its identity as a discipline in the social sciences. The phrase "Mathematisation of Economics" has become very common, even in academic writings, in referring to this evolutionary phenomenon.

This short essay is based on a review of some of the literature, existing in the form of journal articles, books, research reports and websites, in order to establish perhaps a finer microscopic view into this very valuable and timely debate.

T U Hewage
Department of Mathematics, University of Colombo, Sri Lanka.
Email: thilan@maths.cmb.ac.lk Tel: +94 77 358 4223
https://orcid.org/0000-0001-8085-0319

RATIONALE

Though there seem to be two main camps, one promoting and the other opposing, the mathematization of economics, it will be more fruitful to explore the possibilities of using both mathematics and economics, among other things, in helping our planet. Helping here means, helping its sustainable development activities leading to better living standards to all the inhabitants of it. Especially since the whole world is trying to determine the best possible ways to get the economic activities functioning again, during this post-COVID-19 period, it would be an excellent opportunity for all the nations of the world to revisit their policies, rules and regulations and improve all of them using all the lessons learned. Each country will be focusing on the ways to get its people living their lives the way they used to or better. The two main factors addressed immediately would-be a) stopping the spread of the virus and b) the revival of the economy. There will be all kinds of mathematical and economic models, currently available and also newly created, that would be used in handling both those tasks a) and b) around the world. Existing models should be analyzed thoroughly to see whether they would address the post-COVID-19 requirements at all. If not, perhaps it could be modified or else create a new model that would fit in well with the current requirements and also the future expectations of the world. Therefore, an in-depth look at the effect of mathematics in economics could be a vital ingredient that should not be left out of the recipes for creating these decision-making models and procedures.

SEPARATION OF DISCIPLINES

Starting from the latter part of the 19th century people started treating different areas of interest such as mathematics, physics, chemistry, biology, sociology, geography, economics...etc. in their own individual cocoons and specialize in one of them without paying much attention to the connection of that to any of the other disciplines. Branching out into more and more specific areas became the trend in the academic world where the competition among them was even encouraged as a natural stimulant to increase the rate of development of each discipline. Little that they realized, this branching out, though it facilitated certain economic benefits through career advancements and marketability of expertise, was taking them into isolation through narrower and narrower arteries. This trend can be seen even within a particular discipline due to overcrowding of these arteries. Overcrowding is felt due to competition. The competition creeps in because there is a market for knowledge. The market then controls all the economic factors influencing the individual or the group. This is one of the reasons why this concern about "mathematization of economics" has even come up as a topic for discussions.

A century of forced separation of different branches of knowledge inadvertently made the researchers in one discipline insensitive to the effects of their actions on any of the other

disciplines. When things went wrong with some of the policies introduced in some countries during this period it was not easy even to find out what went wrong and why, since the experts themselves were trying to analyze things with their tunnel vision. The trend of separation and isolation started to change towards the latter part of the twentieth century and "inter-disciplinary" or "multi-disciplinary" research became magic words, in the twenty-first century, that could even pull more research funding out of the hats.[11]

THE MARRIAGE

If Mathematics is considered as a member of "Physical Sciences" and Economics, as a member of "Social Sciences", then it certainly can look and feel like an unnecessary contamination of one with the other. That contamination was even made to look like an invasion when the very first "Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel"[1] was awarded to two mathematicians, Ragnar Frisch and Jan Tinbergen, for successfully using dynamic mathematical models for the analysis of economic processes, in 1969.[6][7] They are credited as the founders of "Econometrics", which facilitated an enviable marriage between mathematics and economics. Needless to say, that econometrics became the most popular branch of economics among the proponents of mathematization of the subject while the opponents, the neoclassical economists were warning about dehumanization of economics by consummation of this new marriage.

Econometrics uses mathematics and statistics together with economic theories to quantify economic phenomena and has become the most important tool in economic policy making throughout the world. Mathematical Economics, Forecasting and Market Analysis are some of the other areas in economics that use mathematics heavily in refining their theories and applications.

Economists, in general, are in agreement that using mathematics and statistics, as and when needed, with the proper intentions is both necessary and helpful. Use of mathematics in this context is seen not only in economics but also in almost all other disciplines irrespective of their categorization being in the physical or social sciences. Disciplines coming under physical sciences usually welcome the mathematization with open arms with the feeling of welcoming a long-lost family member who is back to help

[1] It is interesting to note here that the original list Alfred Nobel had mentioned in his last will for the prizes to be awarded included only five disciplines, Physics, Chemistry, Physiology or Medicine, Literature and Peace. Prizes for these five disciplines, funded by Nobel's private fortune, were awarded in 1901 for the first time. A prize for "Economic Sciences" was established by Sveriges Riksbank (Central Bank of Sweden) in 1968, in memory of Alfred Nobel, where the bank agreed to provide the funding for the prize with the Nobel foundation announcing it together with the other five Nobel Prizes. Therefore, it is safe to assume that both mathematics and economics were not considered, by Alfred Nobel at that time, as disciplines that can make significant enough contributions to humanity, to be recognized, as the other five. [10]

them out in a difficult situation.[17] But the concern about the overuse of mathematical theories in economics sometimes even overriding the inapplicable and unrealistic nature of outcomes is what created an opposition for the mathematization of economics. This overreliance on mathematics may have contributed to economic disasters around the world over the years, including the failure to predict international financial crises in time, to make relevant players aware of the imminent dangers. No matter how beautiful the mathematical theories look and how smoothly the models work in a perfect environment defined by the variables included for the model and subject to the assumptions made, there is a very good chance that it will not work in real life since it is impossible to formulate human actions. There are enough people, including policy makers, who are willing to take the risk especially when the failure of the theory or the model is not going to have much of a negative effect on them. But the irony is that same thought process and the theories and models based on mathematics attract people to rely on predictions made on stocks, bonds and other markets where they can trade options and futures. Interestingly enough, the concept of deciding a price according to the future expectations and buying options has been tried successfully by Thales of Miletus (624 – 547 BC) by using his knowledge of "stars" to predict the type of olive harvest months ahead and paying deposits on all the oil-presses in advance.[12] That perhaps was nothing more than a clever usage of astrology which is also based on mathematics. Usage of astrology for future predictions and/or finding out the causation of certain phenomena which were difficult to explain otherwise was an ancient practice which is still in use by the modern forecasters and/or gamblers from time to time, though they may shy away from admitting it. People in the caliber of Charles M. Schwab and J. P. Morgan who are considered as successful businessmen were known to have consulted the famous astrologer Evangeline Adams before they made important business decisions. It is interesting to note that, when Ms. Adams was accused of illegally helping some of the players in the financial market to gain an edge over the others using a pseudoscience (or witchcraft) she managed to get an acquittal by showing the courts that astrology is based on astronomy which is based on mathematics and therefore it is a pure-science and should not be considered illegal. [5

There have been numerous mathematicians, mathematical economists and econometricians who have won the "Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel", which is considered as the highest honor in the field of economics, since two mathematicians won it in 1969 for the very first time. But when it comes to analyzing the "Effects of Mathematics in Economics", the difference of opinions can clearly be seen even among them where Nobel Laureates such as Paul Samuelson promoting the use of mathematics even more while others like Gerard Debreu and Maurice Allais have raised the caution flag encouraging economists to give due consideration to all the other factors such as sociology, psychology, philosophy, political science and even art and literature as well.[14] With this repeated recognition of mathematization of economics all the way up to the Nobel prize, economics became the

most scientific discipline out of all the social sciences. This slowly made way to a hierarchical structure even within the discipline of economics itself. Economists supporting the mathematization claim that those who oppose lack the mathematical background and the opposition claims that most of the mathematical theories and models used in economics are not realistic at all.[1][9]

AN EXAMPLE OF A MATHEMATICIAN WHO WAS ALSO AN ECONOMIST

There is no doubt that the developments in both mathematics and economics we have experienced so far have had an enormous impact on the process that brought humanity where it is today. Needless to say, there are instances throughout our history where advancements in mathematics and/or economics have been used constructively as well as destructively. Developing theories is one thing and using them in a particular decision-making process is another. A very good example of this is, the use of the mathematical knowledge of the brilliant mathematician/chemist/computer scientist and economist, John Von Neumann. A brief history about Neumann's life is mentioned here in order to highlight the interdisciplinary nature of knowledge and also the inability to predict how and when any knowledge or information can and will be used. A child prodigy, born in Hungary in 1903, Neumann finished a degree in Chemical Engineering and a PhD in Mathematics by the age of twenty-three. He was fortunate to get an opportunity to work with the famous mathematician David Hilbert in Germany and published the "Theory of Parlor Games" in 1928, at the age of twenty-five, the paper that revived then dormant field of Game Theory. Encouraged, among other things, by the book "*Theory of Games and Economic Behavior"* by Von Neumann and Morgenstern, John Nash did his graduate studies in Game Theory in the late 1940s and was awarded the Nobel Prize for Economics in 1994. Then in 2012 the Nobel Prize for Economics was awarded to two other mathematicians Alvin E. Roth and Lloyd S. Shapley, inspired by Nash, Von Neumann and Morgenstern,[16] for coming up with the "Theory of stable allocations and practice of market design".

Even though this theory was initially looked at as just a better way to select marriage partners from two groups of eligible men and women, later proved to be an extremely valuable tool in matching patients needing organ transplant with possible donors, in evolutionary biology and even in the political arena in creating winning coalitions. In addition to his work on Game Theory and other areas of mathematics, Von Neumann is recognized for his work on quantum theory, automata theory, economics and even defense planning. He was one of the founding partners of Allan Turing in creating the first prototype of the general-purpose computer. There is no doubt that all of those would be considered as positive contributions to mankind by Von Neumann. He was also credited as the main scientist who came up with the faster and more efficient implosion design of the atomic bomb. He was even included in the target selection committee of

the Manhattan Project where he was responsible for choosing Hiroshima and Nagasaki as the first targets and also for the computations related to the expected size of the bomb blasts, death tolls, and the distance above the ground at which the bombs should be detonated for maximum effect.[8] Is it a positive contribution since it helped bringing the WWII to an end? Is Von Neumann a mass murderer who has directly involved in the process of killing millions of human beings along with all other forms of life in those two cities? First extremely interesting point that cannot be ignored is that there is no reason for a genius of the caliber of Von Neumann to miss the fact that the main cause of the war is the greed for wealth on the planet. Therefore, his involvement in the war, though it is through his mathematical and quantum physics knowledge, can also be related to economic factors. Second point is that Von Neumann came to the United States of America in 1930, three years before Hitler came to power in Germany, since he was offered an academic position at Princeton. There was a very good chance that he would have been killed by Hitler's forces or been forced to use his knowledge in support of Germany, had he stayed there during that regime. Third important point to notice is that Von Neumann contributed in several different fields at the highest level and hence he was not only recognized as a mathematician but also as a chemist, physicist and an economist and also as an inventor of automata theory. These three points highlight the following general properties.

a) Knowledge is neither good nor bad. Perhaps the way it is used can be categorized as good or bad.

b) Knowledge has no territorial boundaries.

c) Knowledge doesn't have to be compartmentalized.

WHAT IS MATHEMATICS?

Oxford Dictionary defines "Mathematics" as "The Science of Numbers and Shapes" while Wikipedia explains it as "The study of such topics as quantity, structure, space and change". Aristotle (384 – 322 B.C.) is credited for describing mathematics as "The science of quantity". "The science that draws necessary conclusions" was a popular description of mathematics, introduced by Benjamin Peirce in the 1800s. [3] Bertrand Russell introduced the idea that "All mathematics is symbolic logic" in the 1900s. Mathematics has been identified at times as "a Language" or "a Philosophy" and other times even as "an Art". Mathematics is the art of interpreting, quantifying and working with error and uncertainty. It is not only concerned with everyday problems but also with using imagination, intuition and reasoning to find new ideas and to solve puzzling problems.[13] At present the world is comfortable accepting mathematics as a combination of all those descriptions.[15] It also shows that "Mathematics" has no generally accepted definition though it deals with "Well Defined" concepts all the time.

WHAT IS ECONOMICS?

Merriam-Webster Dictionary defines "Economics" as "a social science concerned chiefly with description and analysis of the production, distribution and consumption of goods and services" while Adam Smith defined it as "an inquiry into the nature and causes of the wealth of nations". The Online Etymology Dictionary shows that the origin of the word "economy" can be traced back to the Greek word "Oikonomia" which means "Household Management" and therefore "economics" would mean the "knowledge and principles of household management". The economic philosophy of Hebrews dating back to about 2500 BC did not consider any economic problem without connecting the dots with the existing philosophical, ethical and political framework at the time. Therefore, as in the case of mathematics, the world is now comfortable in accepting economics as a combination of all these descriptions.

CONCLUDING REMARKS

Mathematics can certainly help the household management by helping to analyze the production, distribution and consumption of products and services with quantifying the quantifiable and improving the networks and using the imagination and intuition to identify and minimize the errors and uncertainties. But if mathematics is used for the sake of using something abstract so that economics will look more scientific which will help winning a prize or one's academic status then it will not provide any immediate benefit to the rest of the world other than the few who were involved in creating it.

We should also not forget the fact that abstract mathematical ideas have not always given rise to immediate tangible results and can stay dormant for centuries before certain other conditions come together for people to see the possible applications of them. This shows that after completing a full circle of separating different disciplines and then again putting them back together with multidisciplinary approach of solving problems, the time has come to start analyzing economic problems with the intention and expectation of improving the knowledge and principles of household management, with due consideration to existing cultural, philosophical, ethical and political framework at the time. In order to have the thought, "all these disciplines with different names really come together after a certain level of awareness anyway", stimulated, it seems appropriate to end this essay with the statements that Wikipedia uses to introduce Leonardo Da Vinci.

"Leonardo da Vinci was an Italian polymath of the Renaissance whose areas of interest included invention, drawing, painting, sculpture, architecture, science, mathematics, engineering, anatomy, geology, astronomy, botany, paleontology, cartography, music and literature. He has been variously called the father of paleontology, ichnology and architecture and is widely considered one of the greatest painters of all time.

REFERENCES

Algan, Y., Fourcade. M., Ollion, E., The Superiority of Economists, Journal of Economic Perspectives, Volume 29, No. 1, pp 89–114

Atomic Heritage Foundation (2019) John von Neumann, Available at: https://www.atomicheritage.org/profile/john-von-neumann (Accessed: 05 May 2020)

Committee on Facilitating Interdisciplinary Research, Committee on Science, Engineering, and Public Policy (2004). *Facilitating interdisciplinary research*. National Academies. Washington: National Academy Press, p. 2.

Eisenhardt, M (2017) Jan Tinbergen, Available at: https://en.wikipedia.org/wiki/Jan_Tinbergen (Accessed: 05 May 2020)

Eisenhardt, M (2017) Ragnar Frisch, Available at: https://en.wikipedia.org/wiki/Ragnar_Frisch (Accessed: 05 May 2020)

Ekelund, R. B., Hebert, R. F. Cournot and His Contemporaries: Is an Obituary the Only Bad Review?, Southern Economic Journal, Vol.57, No.1, pp. 139-149

Franklin, James (2009). Philosophy of Mathematics. P.104. ISBN 978-0-08-093058-9

Janeway, W.H., Kitson, M (2014) Does Economics Need Less Math or More?, Available at: https://www.cam.ac.uk/research/features/does-economics-need-less-maths-or-more (Accessed: 05 May 2020)

Khan, L. A., What is Mathematics-an Overview, International Journal of Mathematics and Computational Science, Vol. 1, No. 3, pp. 98-101

Levinovitz, A.J (2016) The New Astrology, Available at: https://aeon.co/essays/how-economists-rode-maths-to-become-our-era-s-astrologers (Accessed: 05 May 2020)

Makropoulou, V., Markellos, R. (2005) What is the Fair Rent Thales Should Have Paids , Available at: https://www.researchgate.net/publication/241334729_What_is_the_Fair_Rent_Thales_Should_Have_Paid (Accessed: 05 May 2020)

Nobel Media (2009) Nobel Prize Facts, Available at: https://www.nobelprize.org/prizes/facts/nobel-prize-facts/ (Accessed: 05 May 2020)

O'Connor, J.J., Robertson, E.F. (2013) Nicolas Francois Canard, Available at: http://mathshistory.st-andrews.ac.uk/Biographies/Canard.html (Accessed: 05 May 2020)

Quddus, M., Rashid, S., The Overuse of Mathematics in Economics: Nobel Resistance, Eastern Economic Journal, Vol. 20, No. 3, pp. 251-265

Russell, Bertrand (1903). The Principles of Mathematics. P. 5.

Von Neumann, J., Morgenstern, O., & Rubinstein, A. (1944). Theory of Games and Economic Behavior (60th Anniversary Commemorative Edition). Princeton; Oxford: Princeton University Press. doi: 10.2307/j.ctt1r2gkx

Wigner, E., The Unreasonable Effectiveness of Mathematics in the Natural Sciences, Communications in Pure and Applied Mathematics, vol. 13, No. I: New York: John Wiley & Sons, Inc.