Ricardo Mansilla Corona*

Prof. Rosario Nunzio Mantegna

ROSARIO NUNZIO MANTEGNA es uno de los fundadores del campo de investigación interdisciplinaria conocido como econofísica. Comenzó a trabajar en el análisis y modelado de sistemas sociales y económicos con herramientas y conceptos de la física estadística en 1990. Publicó el primer trabajo de investigación sobre el comportamiento de un mercado financiero utilizando conceptos de la física estadística en una revista de física en 1991. Es también coautor del primer artículo de análisis de series de tiempo financieras en la revista *Nature* en 1995. Publicó, en 1999, junto con H. Eugene Stanley, el libro *Introducción a econofísica: correlaciones y la complejidad en finanzas*, que es probablemente el libro más citado sobre el tema en el idioma inglés. En el momento de escribir estas líneas el libro tenía más de 3,770 citas. Rosario Mantegna obtuvo su posición de profesor asociado en 1999, fundando el Observatorio de Sistemas Complejos del Departamento de Física de la Universidad de Palermo, donde aún es profesor. También es, hoy en día, profesor honorario en el University College de Londres, Reino Unido, y es miembro (externo) de la facultad del Complexity Science Hub de Viena, Austria.**

Rosario Nunzio Mantegna is one of the founders of the field of interdisciplinary research known as econophysics. He began to work in the analysis and modeling of social and economic systems with tools and concepts of statistical physics already in 1990. He published the first paper investigating a financial market using concepts of statistical physics in a physics journal in 1991. He also co–authored the first work analysing and modeling financial time series in the journal *Nature*

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in 1995. He published in 1999 with H. Eugene Stanley the book *Introduction to econophysics: Correlations and complexity in finance*, which is probably the most quoted book on the subject in the English language. At the time of writing these lines, the book had more than 3,770 citations. Shortly after Rosario Mantegna obtained his associate professor position in 1999, he founded the Observatory of Complex Systems within the Department of Physics of the University of Palermo, where he is still a professor. He is also currently a honorary professor at University College London, UK, and he is member of the external faculty of the Complexity Science Hub Vienna, Austria.***

Prof. Mantegna, I dare say that you are one of the "Founding Fathers" of econophysics. Could you tell us about the motivations that inclined you to this area of research?

I started to use statistical physics concepts in the analysis and modeling of economic and financial complex systems just after the completion of my PhD in Physics. This was at the end of 1989. In my PhD research project, I studied and used concepts and tools of stochastic processes, deterministic chaos, and noise modeling. My PhD thesis was an experimental thesis dealing with a quantum system subjected to a driving signal having both a periodic and a stochastic part. The study of the role of well–controlled stochastic processes in the dynamics of real systems suggested me to perform a similar type of analysis and modeling in systems of high social interest as the financial markets. The idea was along the line of what was developed during those year at the Santa Fe Institute in the USA, where physicists and economists joined their effort to model a large variety of complex systems including complex systems of social and economic origin. For example, the interest towards the so called 1/f noise motivated scholars as Per Bak or Wentian Li to analyze the spectral density of return of important stock indices such as the Dow Jones 30. In other areas of statistical physics, scholars like Mike Schlesinger and Joseph Klafter were obtaining results about the so–called Lévy walks, *i.e.*, random walks characterized by long memory and large jumps. These cultural influences convinced me that it was the time to attempt analysis and modeling of economic and social complex systems with the background of statistical physics, chaos theory, and agent based modeling.

In your early work you expressed an interest in the distribution of price differences in the markets. Despite the results obtained by you, E. Stanley and other researchers, this seems to be still an open problem. Can you tell us your perspective on this issue?

I fully agree with your view that the problem of the exact nature of the process describing the stochastic dynamics of return of a financial asset traded in an

*** Prof. Mantegna agreed to this interview at the request of the editor of this journal.

efficient (or close to efficient) financial market is still today an open problem. In my opinion, one major difficulty concerns the fact that the time series of return of a financial asset is not a simple stationary process and therefore the real nature of the stochastic process is quite sophisticated. Econometrics has suggested that one approach could be the one of auto–regressive stochastic processes. Econophysics has put in emphasis the fact that wide metastable scaling regimes can be observed. In fact, one of the major contribution of econophysics has been to show that both leptokurtosis and finite second moments are simultaneously present ending up in the presence of a wide metastable scaling regime.

My view about the return dynamics of a financial asset is that such dynamics reflect all the information that the market process. This information is in some cases exogenous and correctly interpreted by the economic actors trading in the market but in other cases it might be endogenous and/or just misinterpreted. In other words, in financial markets noise and signals are mixing the one with the other and the economic actors try to disentangle this mixing in an environment that minimizes the arbitrage opportunity. This highly complex process of information processing is reflected in the statistical properties of price dynamics making the return distribution an indicator which is quite rich and sophisticated to be described by just a simple stochastic process.

Reviewing your most recent researches, I note that there is an emphasis on multiagent models and complex networks. Could you tell us a little about these recent projects?
Yes. My recent research considers the investment profile of single investors in different conditions. With the term single investor, I mean a single legal entity such as, for example, a company, a bank or a single individual. The reason why I got interested to this type of studies originates from the observation that social and economic complex systems are heterogeneous complex systems. The different economic actors acting in a financial market are different actors. Economic theory deals with heterogeneity present in economic systems by subsuming differences within the idealized concept of the representative agent. My view is that there are many economic, financial, and social problems where the heterogeneity of the system is an essential aspect that cannot be washed out with a kind of "mean field" approach. When this is the case, other concepts are more appropriate. One concept is the concept of ecosystem and ecological diversity. Another possible approach is to use instrument that directly reflects or can deals with the heterogeneity of the system. One of these instruments is certainly the concept of complex networks. Complex networks are heterogeneous and in fact they have been extremely useful in describing and modeling economic systems especially when problems about the stability of a global heterogeneous system are considered.

Ettore Majorana was may be the most brilliant student of Enrico Fermi, an outstanding physicist and as I understand it a scientific figure very dear to you. Which were in your opinion the most important contributions of Majorana in the interdisciplinary confluence between physics and economy?

Ettore Majorana was one of the major figures in the group that clustered around Enrico Fermi in Rome in the late twenties and thirties of the last century. Among the members of this exceptional group (exceptional not only for Italian standards but also for world standards) he was certainly the most original one in the sense that he was selecting scientific problems only based on his own scientific interest and independently of the fact whether problems also were of interest or not for the research community of his time. This unusual attitude is reflected in the fact that his contributions to science are extremely original and completely out of context during the period when they were proposed. His major contribution concerns the proposal of a new form of a Dirac's equation predicting the possibility of a neutral particle that is simultaneously a particle and an anti-particle. Particles of this class have not yet been discovered but they are today (after 80 years of their theoretical introduction) searched and considered both in neutrino's theory and modeling (the so–called Majorana's neutrinos) and in condensed matter. The other original conclusion was about the observation that quantum mechanics description of irreversible phenomena of single quantum entities (such as a single atom) show that the deterministic description of physics is valid only for a limited set of phenomena and a statistical description is unavoidable for a large set of physical phenomena. This is today acknowledged by most physicists after the development and successes of quantum mechanics and after the results obtained in the field of deterministic chaos but was a quite original point of view in the thirties of last century.

Despite decades of interdisciplinary research in econophysics, the economic theory taught in universities does not seem to have received much influence from it. Do you think that in the future there will be a convergence towards economic theories closer to the spirit of econophysics?

My view is that econophysics is a hybrid science, *i.e.*, a science that is covering a research area at the interface between the two disciplines of economics and physics. In my opinion, the present time is a time of hybrid sciences producing many research areas and research communities covering a scientific field between two established disciplines. Other examples are bioinformatics, neurosciences, and computational social sciences. Within this view, I do not expect that economic theory will change its paradigms and research styles or correspondingly that physics will change its own. The process I see is a process where mutual influence between the two disciplines is fostered by the presence of a research community working at the interface between the two major ones. For example, econophysicists promoted the empirical investigation of economic problems starting from rich and detailed economic and financial data also in the absence of an underlying micro founded theory. This was explicitly discouraged by economists in the past decades. Recently, this is not more the case and in fact leading economic journals are nowadays considering articles where data analysis is a predominant part of the study and prestigious universities have data mining courses within the curriculum of economics. Proximity based and association networks are today investigated and visualized in the research groups of many central banks and are becoming popular within econometrics. I think these changes have also been due to the practice and results obtained by econophysics. On the other hand, some problems that have been of primary interest for statistical physicists have originated from problems originally posed in economics or finance. One prominent example is the so–called minority game that originated from the "El Farol bar" problem. Another influence from economics to statistical physics is the attention to devote to the procedures of statistical validation. Statistics is present at an elementary level in most physics problems and the interaction with economics and finance has stimulated many physicists to achieve a much better control of the statistical tests they perform in their analyses. Id