SOME TYPICAL ECONOPHYSICS' AND SOCIOPHYSICS' MODELS

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Abstract. *Some typical Econophysics' and Sociophysics' models result from this new sciences' way of thinking or from the physicist's methods used in other domains as Economics and Sociology. This paper describes the improvements of the quality in the classical research of Economics and Sociology through some of these new and still typical models and tries also to investigate why econophysicists' and sociophysicists' models are able to perform financial or sociological analysis, and which are their most interesting strengths and weaknesses. Econophysicists' and Sociophysicists' models seek to integrate the Physics' methods and laws with classical Economics' and Sociology's theory and thinking, seeing this new domain of applied Physics as an unlimited one. Econophysics and Sociophysics replace conventional ways, with the new and broader views of Physics' thinking. The author believes that an important scope and intention of this paper is to draw a repertory of some typical models for the use of Economics and Sociology. In addition to this main purpose, the paper could be a statistical evaluation of some not so typical phenomena as crises or recessions, which can be reordered along the new coordinates of contemporary Physics' thinking and specific models.*

Keywords: *Statistical Physics, Econophysics' model, Sociophysics' model, power law, diffusion, weak and strong signals.*

1. Introduction

Econophysics and *Sociophysics* describe applications of Physics to different fields, similar to Astrophysics, Geophysics, and Biophysics. The specific fields or domains are in these distinctive cases Economics and Sociophysics.

Thus, *Econophysics* is an "interdisciplinary research field applying methods of statistical Physics to problems in Economics and Finance" [1]. The contemporary way to define Econophysics is to do so in terms of the

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ideas that it involves in effect physicists doing Economics with theories from Physics, this raises the question of how the two disciplines relate to each other and it explains interest rates and fluctuations of stock market prices, these theories draw analogies to earthquakes, turbulence, sand piles, fractals, radioactivity, energy states in nuclei, and the composition of elementary particles.

Sociophysics is a new insight into the applicability of much of elementary statistical physics to the social sciences. *Sociophysics* means a new insight followed by transferring and further developing ideas and concepts common to Physics, Biology, and Ecological Systems. First named Psychophysics, Sociophysics can be described as the sum of activities of searching for fundamental laws and principles that characterize human behaviour and result in collective social phenomena. Sociophysics tries to model the dynamics of social and economic indicators of a society and investigate how life extension will influence fertility rates, population growth and the distribution of wealth [2], religion, friendship and sex, social network, traffic etc. *Sociophysics* has become an attractive field of research over the last two decades, despite the controversies between sociophysicists and sociologists. Its relevant potential used for understanding the social phenomena always will win.

Econophysics and Sociophysics improve the quality of the classical research of Economics and Sociology through their original models. New models, already called typical after only five years, result from a new way of thinking or from the trans-disciplinary methods used in new domains.

2. The scientific research model

The expansion of contemporary science has multiplied their number to over 1,000 independent sciences, especially within borderline areas (e.g. econophysics, situated at the border between physics and economics, sociophysics – at the border between physics and sociology etc.). Science emerges when at least three elements are joined together: a distinctive theory, a segment of reality as a specific object, and a model interposed between theoretical investigation and its object of study. Sciences have their own characteristic models and laws, acquired mainly thanks to their inclination for measuring their object of study.

From the tetragrams of the ancient Chinese culture to abstract or geometrical figures in ancient Greece, from the first music sol-fa systems to the everyday languages used by calculus programs, all these types of presentation laying special emphasis on the logical element of a visual nature have been, and are still, simplified alternatives to modelling.

In a relevant way, the model and modelling have been situated, through their initial practical uses, close to geometry, than any other scientific domain. The appearance of the term as such is linked to the year 1868, when the mathematician Eugenio Beltrami managed to construe an early Euclidian model for non-Euclidian geometry.

For the first time, he was turning the model and modelling into a concept, studying, by their agency, "a domain, a phenomenon, an object inaccessible to direct research". The geometry-inspired model became "a coagulant factor" for scientific thinking, a continuous process of pondering, represented, symbolized and conveyed, no less than the tetragrams were to Gottfried von Leibniz the inductive solution to the mechanic system of his own calculating mechanical device. At a higher level of elaboration, models are scientific representations, or representations of scientific theories. Paraphrasing Parmenides, the model that can be thought, and the one for which the thought exists are one and the same. Theoretical science, a permanent source of experimental suggestions, becomes at once experimenting and foreseeing, and along these lines the basic conditions of multi-dimensional modelling can be synthesized as follows:

– the first condition for a model is its direct relationship with thinking ("a bird is a machine functioning in accordance with the laws of mathematics, an instrument that man can reproduce with all its motions" – to quote Leonardo da Vinci, in *Macchine per volare*);

– a second condition is the identification of the essential aspects, and formulating questions in a correct manner;

– the profoundness, the intensity, and the depth represent the third condition of representation through models (the oscillation between analogy and he convention-symbol);

– the efficiency of the transposition, or the translation of the theory into the reality of the world under study seems to be anther condition, the superior models becoming themselves objects of research and re-modelling [3].

In keeping with the reasoning of modelling, as maximum fidelity translation or transposition, any theory corresponds to a model, and any model, when validated through the agency of reality, will correspond to reality. However, the closer the model will draw to the point of intersection of several sciences, the more correct the transposition/translation. Even the exclusive answer to the question “what is a model” constitutes a difficult undertaking, and needs many-sided approaches. Below are some illustrative variants:

– in the option of physics, a model is a calculating instrument, with the help of which one can determine the answer to any question concerning the physical behaviour of the system in question, or else a precise pattern of a certain segment of the physical reality (two examples, which are today as well-known as to become banal, are the modelling of the inertial reference system, and the atomic model);

– in the vision specific to chemistry, the model becomes a structural concept that attempts to explain the properties found experimentally, or a support in deductively passing from the general to the specific, a knowing instrument that forecasts facts and “indicates the numbers” (as in the memorable example of Mendeleyev’ s table of elements, or the periodicity of chemical elements);

– in the approach of biology (genetics), a model is considered a natural modality – reproduced experimentally – of genetically differentiating the populations (the model of DNA being, in this respect, a commonly cited example, and a relevant point in case);

– in the perspective of mathematics, the model is superposed to a certain type of measuring methods, specific to mathematical research, with a view to explain, in an objective manner, the “manner n which the micro-components and their mutual interactions, either interpreted individually, or grouped in subsystems, generate and explain the whole of the system” (Octav Onicescu and the model of informational energy), or a “definition and non-contradictory description of a number of processes and phenomena”, of the theses, postulates and axioms, as well as their logical and mathematical correspondence;

– from a logical point of view, within the structure of the model, the causes equalize the effect (Anton Dumitriu);

– from a behaviourist standpoint, the model presupposes a number of participants gathered in a formal way, who “maximize their utility by starting from a stable set of preferences and accumulate an optimal amount of information in a variety of markets” (Becker’s model);

– along the lines of the semantic, linguistic and explanatory dominant, the model is a theoretical or material system by means of which one can study, indirectly, the properties and transformations of a different, more complex system, where the first system exhibits an analogy (according to the explanatory dictionary);

– in its statistical acceptation, the phase-directed sense of the concept of model is that of a link in an integrated process of knowing, and is made up of a hypothesis, a schematic representation of a process (phenomenon), the statistical testing, and the resuming of the process in a general theory;

– in keeping with modern sciences, the multidisciplinary model becomes the optimum instrument for solving a number of complex general problems, and modelling turns into a series of means meant to disclose the real nature of the problems, where the isolated vision does not allow one to formulate characteristic laws.

– the statistical & mathematical or statistical & physical type of modelling is a mathematical transcription of a number of simplified hypotheses about the state or evolution of a social-economic phenomenon, or physical system under the factorial influence of variables that are physical or can be assimilated to the physical ones (in the modern scientific vocabulary, a statistical model also designates the explanatory hypothesis – model: χ^2, F, t etc.).

The Econophysics' or Sociophysics' models turn to account the language and methods of mathematics, testing and statistical decision, the pattern of physics in assessing (quantum, thermodynamic, acoustic etc.) reality, as well as the real variables of the segment subject to research (money flow in the economy, human behaviour in sociology etc.).

How can one manage to practically construct a model? The starting point is direct experience, or unmediated contact with reality. In order that a theory could be turned an experiment, or into an "organized contact with reality", a theory is formulated, which is subsequently represented by a material, intuitive or symbolic model, as a filtered reflection of reality. Louis Pasteur would elegantly underline the primacy of the theory, through the agency of the well-known formula: "luck favours only the well-prepared minds". Tiberiu Schatteles used to synthesize the likeness between theory and modelling through the phrase "the dogmatics of isolation". For instance, economic models are always partial models, and it is hence always possible to add another equation, quite irrespective of how large the system is. [4] In order to illustrate a phenomenon, the theory isolates it from the contingent, very much as the experiment is underlain by a type of material (i.e. laboratory) isolation. Studying a phenomenon in isolation also presupposes defining the framework of the isolation through postulates or axioms as "something that goes without saying". Due to their isolation tendencies, Econophysics and Sociophysics are somehow sciences of models joined to the art of choosing models which are relevant to the contemporary world. It is compelled to be this because, unlike the typical natural science, the material to which it is applied is, in too many respects, not homogeneous through time. The object of a model is to segregate semi-permanent or relatively constant factors from those which are transitory or fluctuating so as to develop a logical way of thinking about the latter, and of understanding the time sequences to which they give rise in particular cases… In Physics and in other natural sciences the object of experiment is to fill in the actual values of the various quantities and factors appearing in an equation or formula; and the work when done is once and for all. In classical economics, theoreticians think that this is not the case, and to convert a model into a quantitative formula is to destroy its usefulness as an instrument of thought… "To do so would make it useless as a model. As soon as the model is done, it loses its generality and its value as a mode of thought" [5, 6].

Modelling, as a complex iterative process, oscillates between simplified variants like the "triad" (formulating a hypothesis, collecting the experimental material, and verifying the hypothesis), and excessively detailed variants (formulation of the initial model followed by the forming of repartition classes, gathering the experimental material or the data, choosing a particular repartition, checking the degree of concordance of the repartition chosen with the real situation and formulating the hypotheses that explain the random mechanisms that have generated the data). The typological diversity of the models results from the great number of the scientific theories that they reproduce. Seen from the angle of the aim they were created for, the models fall in two major types: the category of the rational or theoretical models, and the category of the operational models, or prediction (decision-making) models.

Through comparison with the time variable, modelling is static or dynamic. A major classification of modelling according to the typology of the explanatory variables reveals the deterministic type of modelling in the past (evolution of phenomena, determined solely by the mechanical, or simply causal variables) and modern probabilistic modelling (which contains perturbing variables, in keeping with the probable effect of some uncontrolled factors and unspecified variables). Contemporary evolutions of Econophysics and Sociophysics led us to the idea that modelling can not be only multidisciplinary. For a succinct description of modelling in Econophysics and Sociophysics, a few clarifications are in order, relating to their architecture and paradoxes, but also to their various stages.

The architecture of multidisciplinary modelling capitalizes on:

a) minimal simplification through hypotheses (it was formulated for the first time by William Ockham as the first economic architecture, or of parsimony) or the existence of a minimal number of propositions not connected mutually, and undemonstrated propositions (out of two interpretations of a phenomenon, the interpretation having fewer supposetions or simplifying hypotheses is preferred);

b) he simple alternative (the highly intricate models failed to lead to categorically better results, as against the simple extrapolation formulas – Koopmans T.C.);

c) the value certified through the dialectical reasoning (a model facilitates the discussion, clarifies he results and limits the reasoning errors);

d) the cultural component (if the humans' economic and social actions were independent of their cultural inclinations, the enormous variability of the economic and social configuration in point of time and place could by no means be accounted for);

e) the shifting from only one discipline to many sciences or to a multidisciplinary model, through successive models (improvement through imitation, through analogy, and through passing from one type to another in Econophysics and Sociophysics).

Modelling in Econophysics and Sociophysics remains a process with a paradoxical content. The paradox of the infinity of the multivariable system is revealed by the infinite number of factors, which cannot be classified in a direct manner, in proportion to the particular model construed out of a finite number of essential factors. The paradox of the "relative reduction of one system to the next" proceeds from relative reducibility, centred on the translatability of the languages concerning various fields of reality, and manifests itself as an antithesis between the functional and the substantial. The paradox of the "unique community" can be translated through the antinomy holding between the correlation of the action of several models, and the building up of a unique model for a given problem. The paradox of the "double idealisation" concerns the phases of simulation, and respectively, of the assignation and interpretation of information within the model. Multiplied, information is not lost from the model, very much as, fragmented, it is nothing but information. The "double idealisation" consists in treating information as "signification" of information in the model of attribution, whereas in the interpretation model it is treated equally as signification and as sense.

The concrete stages of modern modelling in Econophysics and Sociophysics are the following:

1. the structural defining of the system (isolating the phenomenon, formulating the questions, identifying the major interest variables),

2. the preliminary formulation (sets of hypotheses and conclusions concerning the relationships between the variables), collecting the empirical (relevant) data,

3. the estimation of the parameters and of the functional forms,

4. the preliminary (gross) testing,

5. the additional testing (based on the new data),

6. the decision – accepting or rejecting (in conditions of predictions conforming or failing to conform with the available empirical evidence).

Synthetically, the relationship between completeness and precision/accuracy generates specific models (Table 1):

Table 1

Degree of the data's completeness and precision generating the typology of the model

Degree of completeness of the data	**Degree of precision of the data**	**Typology of the model**
Maximum	Maximum	deterministic
Relatively low	relatively high	probabilistic
Relatively high	relatively low	fuzzy
Relatively low	relatively low	intuitive
Minimum	Minimum	nondeterministic

The algorithm of the model has three characteristic features: determinism in point of performance, succession in point of operation, universality in so far as the spatial, temporal and structural entries and limitations are concerned. Modelling exhibits three main ways of analysis:

– using the equilibrium equations between the factors, from Leontief's input-output balance, to the fuzzy ones, and to those of quantum physics, thermodynamics etc. (Leontief's model was subsequently generalized in three distinct variants, i.e. the deterministic, the random, and the information ones, the fuzzy model has impredictable variation parameters, the quantum physics' model means transgresion or transition from energy to light, or from wave to particle etc.);

– identification of the extreme values as the model of the "catastrophes", or of R. Thom's "critical points" – which is the frequently cited example in point;

– construction or simulation of conflict situations through the "strategic games with incomplete information (i.e. competitive situations) or complete information (i.e. open situations).

The uncertainty of decision-making is paramount, all the way from Wald's (prudent or pessimistic) model, characterized by choosing the maximum profit variant, or the minimal loss cost wise, in the most unfavourable situation, to Laplace, which selects the higher average-profit variant, or the lower average-loss, in the hypothesis that the states have the same occurrence probability, to Savage, where an option is made for the lowest possible regret (i.e. the usefulness lost as a result of selecting a different variant than the optimal one, in conditions of complete information), and to Hurwicz, whose coefficient of optimism re-enters, through its real-value interval, the vast realm of the probabilities, namely [from 0 to 1].

To illustrate the above, multidisciplinary modelling maximizes the capacity of reducing the degree of *imprecision/inaccuracy* and of assessing that *imprecision/inaccuracy* through statistical testing and testing in terms of probability theory, whereas even mathematical modelling approximates, while failing to express reality exactly as it is, because reality is not "exact/precise", but subject to the stochastic laws or to the action of the law of great numbers.

To express in a Econophysics and Sociophysics manner how inaccurate a model is, is more important than modeling in a classical, hence sophisticated, isolated manner, lacking the power of specificity. The perspectives of the field of model-construction astonish through the rigour of a new concept, namely that of the system of Econophysics and Sociophysics as multidisciplinary models, which presupposes the following principles:

- the human decision has the fundamental role in its functioning;
- the construction is a logical succession, and also a process of arrangement in time, in keeping with the principle of economy, or the law of parsimony;
- the separation and combination of the individual models occurs in procedure-based chains;
- the system stays open, thus facilitating the adding / the deletion of restrictions and variables;
- the physical-mathematical structure is independent of the manner of utilization;
- the architecture is modular, hierarhical and dynamic;
- the information-based and logical connections are, in turn, part of cooperative, hierarchical, mixed models;
- although including different types of models, the database if unique.

In the natural harmony of the Econophysics and Sociophysics' approach to modelling [7], the contribution scored by discovering of an original model is to be considered much higher than knowing a new phenomenon or process.

The limits of classical sciences' modelling are abvious:

- no classical model can consistently and substantially incorporate the residual variables and areas (which can occasionally be quite considerable in point of proportions and significations);
- both human behaviour and other random variables like the climate, the radical political evolutions such as the revolutions, etc., as soon as they are modelled, bestow an increased amount of uncertainty to the respective model;
- the model has evolved in a credible manner along the coordinates of the chronological series, and less so, however, along those of the territorial series, of the associated / correlated series, in the specific situations of value optimizations, or concerning verisimilar, attainable targets developing programmes.

To conclude, a model can be said to represent an image of a specially selected part of reality, with the aid of which answers can be given to various questions, or problems belonging to an assortment of fields in the area of scientific knowledge can be solved, with a certain degree of realism and a certain limit of error. The main disadvantage of the classical model, if one resorts to the example provided by the very econometric one, is revealed by the lack of accuracy of their prediction, by the representatives of the neoclassical Austrian school of economics Ludwig von Mises and Friedrich von Hayek. The sad balance of the predictions made by the econometric models over the past few years, for all the modern calculation equipment added to the sophisticated classical or uni-disciplinary models, is nothing but an additional confirmation [8, 9].

Econophysics and Sociophysics' models are nothing else than partial models, and it is hence always possible to add another equation, quite irrespective of how large the system is. What seems to be required, then, is a determination of the reliability of the estimates of a given system *within* the system, but *without* adding further equations. Classical model are limited and modern through their multi-disciplinary solutions are more adequate to reality.

4. Some typical models from Econophysics and Sociophysics

Econophysics means also a scientific approach to quantitative economy using ideas, models, conceptual and computational methods of statistical physics. In recent years many of physical theories like theory of turbulence, scaling, random matrix theory or renormalization group were successfully applied to economy giving a boost to modern computational techniques of data analysis, risk management, artificial markets, macroeconomics [10].

In Econophysics, the activities of research focused on economic phenomena but are analyzed by concept, method and model of physics. Here three typical examples are:

a) the derivation of a price's distribution in the stock market (the change in the price "*x*" of stock market could be considered a random among dealers, then can derive a diffusion equation as a Brownian motion, for distribution $f(x, t)$ of price in the stock market) [11]:

$$\frac{\partial f(x,t)}{\partial t} = \frac{1}{k} \times \frac{\partial^2 f(x,t)}{\partial x^2}.$$

b) distributions of the form that follows a *power law* as: $\ln p(x) = -\alpha \ln x + C$, where the constant α is called exponent of the power law, and C is constant and mostly uninteresting (once α is fixed, it is determined by the requirement of normalisation to 1), or in the case of taking the exponential of both sides, this is equivalent to: $p(x) = Cx^{-\alpha}$ (a power-law distribution occurs in an extraordinarily diverse range of phenomena such as Finance, Macroeconomics, Demography's urbanism) [12].

c) a fractal and chaos analysis originating as Benoite Mandelbrot pointed out that the change in the price of the stock market has a fractal structure for certain range of time interval [13,14], and characterized as a self-similar structure expressed as: $x(t) = Ct^D$, where D is a fractal dimension, calculated by the box counting method. The fractal structure is special case of a chaos and chaotic behaviour is very common in a non-linear system as for an economic system; whether the process is chaotic or not can be determined by sign of Lyapunov index λ defined as: $\lambda = 1/n \, \Sigma \log | F'(t) |$, and when λ is positive (negative) then the process is chaotic (non-chaotic) [10].

Modern Econophysics has developed a new learning system for econophysicists, a system consisting of several methodological parts:

1) Basic Mathematics' methods,

2) Basic Econometrics' methods,

3) Echonophysics' methods, including chaos' methods and fractals' methods,

4) Virtual market's methods.

reviewing classical methods and concepts concerning to each part: Mathematical representation and analysis of the economic data for basic Econometrics; the chaos and fractal including the Lyapunov index and the fractal dimension for Econophysics; the Sato-Takayasu model and simulation for virtual market [10].

A very difficult problem in the specific modelling is the testing of the data, model or of the predictions based on modeling. The question is always the same: How well can past information predict future evolutions? The main assumption is that there should be no pattern in the time series of information, or with other words, the information should be approximated by a random walk (and the autocorrelation of the information time series should be negligible). Sometimes the theories of modeling are called or „baptized" with very strange names as they can be found in the literature (i.e. in the efficient market hypothesis there are three major models named the fair-game model, the martingale or sub martingale model and the random walk model [15].

Sociophysics aims at a Statistical Physics modelling of large scale social phenomena, like culture and opinion formation and dynamics, cultural and behavioural dissemination, the origin and evolution of language, competition and conflicts, crowd behaviour, social contagion, gossip and rumours evolutions, Internet and World Wide Web, cooperation and scientific research, appearances of terrorism etc. A good overview of several fields of application and an accessible, entry-level description of many simulation models can be interpreted as forming part of the Sociophysics. For instance, in a paroxysm crisis of fear, opinions can be activated very quickly among millions of mobilized citizens, ready to act in the same direction, against the same enemy, but a lot of phenomena can be studied within the new emerging field of Sociophysics, in particular the dynamics of minority opinion spreading, the rumour propagation, etc [16,17,18]. The most remarkable pioneers of Sociophysics probably are Serge Galam (*Sociophysics: a personal testimony*), Dietrich Stauffer (*Sociophysics Simulations I: Language Competition*), Paris Arnopoulos (*Sociophysics: Chaos and Cosmos in Nature and Culture*). The list is necessarily limited and unavoidably lacking of many important contributions in this research area [19].

In the last two or three decades new interdisciplinary approaches to social science have been developed by natural scientists. The distribution of unemployment required a new understanding of society, the dynamics of social systems has been gradually introduced by W. Weidlich (1972) and H. E. Stanley (1992) and a thermodynamic approach to social problems has been favoured by D. K. Foley (1994), J. Mimkes (1995), A. Drăgulescu and V. M. Yakovenko (2001).

For a better understanding, there are detailed some models of spreading opinions within a human population. Serge Galam was the first who have modelled the spread of opinions within a population and gets an equation of the inertia of democratic systems against changes. In the last twenty years, sociophysicists have introduced a series of Sociophysics models. These could be divided in different general classes, which deal respectively with:

a) opinion dynamics,
b) decision making,
c) competitions / conflicts, fragmentation versus coalitions,
d) income or wealth spreading and concentration,
e) residential segregation, migration dynamics,
f) cultures and languages evolution,
g) friendship and sex,
h) internet and world wide web evolution,
i) religion spreading,
j) social networks dynamics,
k) traffic dynamics,
l) democratic voting in bottom up hierarchical systems,
m) terrorism spreading etc.

Using these original models several major real political social and religious events were successfully predicted (from the victory of the French extreme right party in the 2000 to the voting at fifty-fifty in Germany or Italy). The models are real important tools for a reasonable perspective and make Sociophysics a predictive solid field. Sometimes model are philosophical instruments more than scientific. In the year 2000, Katarzyna Sznajd-Weron have proposed another model of opinion formation, which was based on trade union maxima "United we Stand, Divided we Fall" (USDF) known as the model (SM). The main characteristic of SM model is that information flows only outward. A great hope for the model of Sociophysics is to show similar correspondence between simple interactions among entities (agents being the preferred sociophysical term) and complex behaviour in the final aggregate. A generalized model of opinion formation in a sociophysical way details in a mathematical way the spread of thinking through social groups. In the hypothesis of a system consisting of N individuals (members of a social group), in which each of them can share one of two opposite opinions on a certain subject, denoted as: $\sigma_i = \pm 1$, $i = 1,2,\ldots,N$.

The opinions of the individuals may change simultaneously (synchronous dynamics as in Glauber theory) in discrete time steps according to the rule:

$$\delta i(t+1) = \begin{cases} \delta i(t) & \text{with the probability} \\ -\delta i(t) & \text{with the probability} \end{cases} \begin{cases} \dfrac{\exp(-l_i/T)}{\exp(-l_i/T)+\exp(l_i/T)} \\ \dfrac{\exp(l_i/T)}{\exp(-l_i/T)+\exp(l_i/T)} \end{cases} .$$

In this model parameter „T" could be called the "social temperature" and I means the impact that determines the individual person to change his opinion when $I_i > 0$ [20,21]. Since the 1780s, when Euler invented network theory, till nowadays many models and applications of the graph theory [22] exist under the form of network analysis. A model, proposed by Ausloos, M., Gligor, M., [23] considers that the *M* agents (countries) which the ME time series refer to, may be the vertices of a weighted network. The weight of the connection between *i* and *j* reflects the strength of correlations between the two agents and can be simply expressed as: $w_{ij}(T) = | C_{ij}(T) |$, fulfilling the obvious relations: $0 \leq w_{ij} \leq 1$; $w_{ij} = w_{ji}$ and $w_{ij} = 1$ for $i = j$. One must stress at this point that the link connecting the vertices *i* and *j* does not reflect here either an underlying interaction. Instead, the weight w_{ij} is a measure of the similarity degree between the ME fluctuations in the two countries. The term "fluctuations" refers here to the account of the annual rates of growth of the considered ME indicator. Networks are characterized by various parameters. For instance, the vertex degree is the total number of vertex connections. It may be generalised in a weighted network as: $K_i = \sum_{j=1}^{M} X_{ij}$ (*j* being different from *i*). Thus, the average degree in the network is: $\langle K \rangle = \frac{1}{M} \sum_{i=1}^{M} \sum_{j=1}^{M} W_{ij}$ (*j* being different from *i*). Finally, neither the model itself could solve everything, nor the method could analyse all the details. But there is a major conclusion in Sociophysics, that in modelling the human group's behaviour, a crucial point always remains to study the group decision making and the related issue of the collective opinion formation and dynamics.

4. A final remark and conclusions

The real criticism of Econophysics is the absence of age variable, because models of Econophysics consider immortal agents who live forever, like atoms, in spite of evolution of income and wealth as functions of age, that are studied in economics using the so-called overlapping-generations models. Sociophysics needs more clarity, especially when it envisions probability at the foundation of social theory. There is no contradiction between this new field of Sociophysics and the Statistics. But, certainly, sociophysicists should be more careful when they are justifying their complex models. Sometimes this minds action seems to be averaged out and finally removed by virtue of the *law of large numbers.*

To conclude, Econophysics and Sociophysics models are multi-disciplinarity models and they try to unify, while classical models remains uni-disciplinarity models and they have succeed only to isolate. Thence, the culture of multidisciplinary modelling remains a practical issue, not certainly in as far as that culture is regarded only as a product of life, but life (reality) having become, in that sense, a consequence or an imprint of culture ... *The model needs the three great intellectual faculties, perception, imagination, and reason, and most of all he needs imagination, to put him on the track of those events which are remote or lie below the surface, and of those effects of visible causes which are remote or lie below the surface.* (Alfred Marshall)

The typical models of Econophysics and Sociophysics were and still remain the results of the weak or of the strong signals coming from outside, from the reality, into science's thinking.

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