About

Econophysics, Sociophysics & Other Multidisciplinary Sciences Journal (ESMSJ) provides a resource of the most important developments in the rapidly evolving area of Econophysics, Sociophysics & other new multidisciplinary sciences. The journal contains articles from Physics, Econophysics, Sociophysics, Demographysics, Socioeconomics, Quantum Economics, Econooperations Research, or many other transdisciplinary, multidisciplinary and modern sciences and related fundamental methods and concepts.

CONTENTS

A UNIVERSE OF VARIABLES AND UNIVERSAL CONSTANTS

Gheorghe Săvoiu[1] Ion Iorga Simăn[2]

[1,2] University of Pitesti, Str. Targul din Vale, nr.1, Arges, Romania
e-mail[1]: gsavoiu@yahoo.com; e-mail[2]: ioniorgasiman@yahoo.com

Abstract: *This paper opens a number of other possible approaches by the authors to the need for inferentiating constants in physics, in order to turn them into universal constants, and thus making use of the global and profoundly integrative nature of physics. An introduction concerning the universal type of approach to constants inevitably leads to a brief history of knowledge in a universe dominated by variables and a delimitation of the philosophy of constants, which is followed by a final distinctive approach to universal constants in physics thinking and their resonance in economics. A few final remarks suggest new horizons based on the systemic approach, within the context of econophysics.*

Keywords: *variable, universe, physical constant, universal constant.*

1. INTRODUCTION

In a holistic approach, the economic system can become compatible with the universal physical system, being characterized by homogeneity, dynamics, general equilibrium described by partial imbalances, harmony and harmonized interdependences, etc. The physical system, centred on the principle complex causality, as well as its laws, is what requires the existence of constants that change the cause-effect relationship, and the "relative instability" of the constants, in the sense of variation in value, can generate another universe.

Changing these constants specific to a "terrestrial universe", through economic activities, may result in the extinction of the current universe, i.e. the extinction of humans and human civilization. One can cite here the example of the current context of development of human society, where failure to take account of sustainable development can be seen as maintaining the current constants, which certainly leads to another universe, where humans and human activity certainly disappear.

Thus, the 21st century can be viewed not only as a century of dramatic imbalances, but also a time of deep antinomies, such demographic explosion – implosion, economic convergence – divergence, extreme economic growth – severe and prolonged recession.

The structure of this paper comprises a first section representing a succinct introduction, followed by an equally brief survey of philosophy in search of the meaning of a constant, and a third section, describing the universal constants in physical thinking, which have already become classic, and impact the thinking of economics, or otherwise of full econophysical content, and their echo in economics. A few final remarks support the possible claim to originality as far as the approach announced in the abstract in concerned.

2. KNOWLEDGE IN A UNIVERSE DOMINATED BY VARIABLES, AND THE PHILOSOPHY OF CONSTANTS

The Pythagoreans drew, maybe for the first time in the history of the written and preserved word, a distinction in which they attempted to segment or partition mathematical knowledge in its broad sense, ranging from music to arithmetic, geometry and astronomy [1], in an *ab ovo* conceptual quadrilateral, such as that in Table 1:

An investigative conceptual synthesis of mathematical knowledge in the Pythagorean school, illustrated by discrete and continuous variables

Table no.1

HOW MANY – *discrete variable*, subsisting by itself (strictly arithmetic mathematical variable)
HOW MANY – *continuous variable*, which is required in relation to another variable (music variable)
HOW MUCH – *discrete* or *stable variable* (strictly geometric mathematical variable)
HOW MUCH – *continuous* or *moving variable* (astronomical variable)

Source: The figure represents a synopsis drawn from Bertrand Russell (1914), *Our Knowledge of the External World as a Field for Scientific Method in Philosophy*, Routledge Publishers, New Edition 1996, the Bertrand Russell Peace Foundation Ltd. pp. 168-169, with references to George Johnston Allman, *Greek Geometry from Thales to Euclid*, 23 and *Proclos*, Ed Friedlin, p. 23 and 35, *Nicomachi Geraseni Arithmeticam introductionem*, Ed Tennulius, p. 148

What was already apparent from this philosophical approach to variables was originally Pythagoras' theorem (the famous summation of the squared lengths of the catheters, which is equalled to the square of the hypotenuse ($a^2 + b^2 = c^2$), and then we have the finding that the first presence of a constant in the so diverse universe of variables exclusively referred to the Pythagoreans' mathematical thinking.

Moreover, Parmenides confirmed this statement in a poem dedicated to "one", in which he said that "everything is one", thus denying plurality, as the young Socrates characterized him in Plato's dialogues [2], only to confirm that it was by following the path of truth (that of constant-centred approaches), or via the approach focused on the opinions of the Pythagorean type, that one could found an extensive knowledge of external reality. Reality is described by a goddess in Parmenides's poem as being imperishable, unchanging, uncreated and indivisible (in fact, it was described as a synthesis of several constants aggregated or combined in her body).

Parmenides was joined by Zeno, whose paradoxes were meant to deny the presence and importance of variation and movement, and who even oversized the reality of constants (e.g. the famous paradox of Achilles and the tortoise that will never be caught up with, or the paradox of the flying arrow, which is yet at rest: during a moment, a moving arrow is where it is, but it cannot move because that would require time to have parts, and consequently a moving arrow is reduced to the constant of an arrow at rest.

In Greek antiquity coexisted no less important contributions to the philosophy of constants, coming from other important thinkers, from Euclid and his Euclidean space, to Aristotle and his treatise "On the indivisible lines"; the view of time and space was, for a long time, one of the types of equivalence space–time as a way of building with points, i.e. with

indivisible moments.

In Aristotle's *Physics* the Pythagoreans are considered as determinant in using the constant of vacuum, considered a "separator" between consecutive elements, including the world of mathematics and numbers differentiated by the same constant element called vacuum… "Nothing was born out of nothing. The universe consists of bodies and void" (Diogenes).

Another confirmation of the time constants later came from Leibniz (whose faith in finite or relatively constant sets thus became a certainty), through his demonstration of the fat that there can be no infinite numbers, i.e. by calculating the "number of all (finite) numbers", which cannot be greater than the number of even numbers, very much like the whole cannot be smaller than one of its parts. [3]

This brief overview of the philosophy of constants, linked to the human desire to know a reality described by a universe of variables, ends with Hegel, who recognized that you cannot think that what is not there is not really exists, which ensures complete similarity between being and thinking [4], thus highlighting the constant "to be" (under the relativized concept of possible), in full antinomy with inconsistency, turned into impossible, of nothingness.

A distinct attitude could be perceived in Galileo Galilei's *Dialogues*, where he identified a constant of infinite numbers, namely the fact that the attributes of equal, higher or lower have no meaning, nor can they find a place in the universe of infinite numbers (of infinity). [5]

As we make a shift into mathematical logic, at the end of this section, we can see in Gottlob Frege's *Grundgesetz der Arithmetik* [6] that the number itself becomes a non-sensitive logical concept (the similarity with constants is more than obvious) and objective, and later Bertrand Russell creates the notion of "logical constants", without however defining them as "entities", but having recourse to "the context and their formalism," while never transforming them into "logical subjects" [7] by themselves.

3. UNIVERSAL CONSTANTS IN THE THINKING OF PHYSICS, AND THEIR RESONANCE IN ECONOMICS

To understand the universe at its deepest level one needs to know its behaviour, and also why the Earth and the human population exist, why there is a particular set of laws and not any other for this universe, and what the role of constants generated by the laws of physics is.

The first and simplest definition given by astronomers about the universe could be the one according to which the universe was all that we can perceive. Thus delimited, the universe is reconceptualised through its quality as being observable or visible, and includes all the stars and galaxies, from the nearest to the farthest ones, which can be detected directly by receiving the radiation they emit. So the observable universe cannot be precisely defined, it essentially depends on the instruments available.

Another conceptualization identifies as universe everything observable, plus everything that might exist. This exhaustive delineation represents the whole universe, which forms rather the subject of mathematical and philosophical studies, by extrapolating of the data that are known in the observable universe.

The substance of the universe and nature has both matter and form [8]. Substance has several attributes, but the spatial one refers to its nature and essence. An object represents a synthesis of the components through which it exists, but is always something more, because a system is not equal to the sum of its components. An object is a frontier world, separating two different worlds.

Its existence separates three worlds; for the inner world, unlimited to the lower extremity, the object is the upper limit, and for the outer world, unlimited to the upper extremity, it is a lower limit. Therefore, in the object there are simultaneously three worlds, the world of the object, its outer world and its inner world. The object reflects the existence in its totality, and it is made by means of a dynamic equilibrium. An object has a scope or extension through which it also exists in space. At the same time, by having a beginning and an end and being permanently in change, it has aduration, it practically exists in time.

Objects exist in space and time, and German philosophy found, with Kant, that "one can conceive of a space without objects, but objects without space are not to conceive of." Objects may disappear, but not the space they occupy. Space is more general than the object, and Isaac Newton imagined space as a blank infinity (thus taking over the ancient Greek philosophers' idea of vacuum in his thinking). The density of matter and the energy in the universe can be justified if the dark matter greatly exceeds the detectable matter.

Cosmic vacuum is energetically a superfluid, where there is no phenomenon of friction or resistance, which allows information, imprints and its patterns to continually exist in the form of a memory, cosmic memory, and evolve dynamically in physical reality.

A third notional delineation encompasses the part of the whole universe which is described by the known laws of physics. This is the physical universe, a slight extension of the observable universe, including areas that cannot be observed directly, but whose presence can be inferred from their effects on a number of observable entities. Scientists discovered a deeper dimension of the universe, that they gave different names: the physical space – the physical time, hyperspace, holographic field, implicit order or non-ether.

This dimension is associated with a virtual ocean of mysterious energy improperly called *cosmic vacuum* (which contains virtual particles and energies that appear and disappear from the physical existence so rapidly that it has no effect whatever on the total energy of the universe), because it is not vacuum, but cosmic space that is not empty, called unified vacuum or unified field.

The universe, in its classical acceptation, proved to be erroneously described, conceptualized and analysed.

The primary element of the universe is energy rather than matter, and space is neither empty nor passive, but *full of virtual energies and information*. The universe is an integrated evolution system, astonishingly coherent and interconnected.

The universe today is remarkably homogeneous and approximately flat, although the calculations for the initial model show that it should not have been homogeneous, on the contrary, it should have numerous regions where space is strongly deformed. To solve the problem, cosmologists filled the model with the so-called inflationary theory, which claims that immediately after the birth of the universe, when it was only 10^{-35} seconds old, it went through a phase of extremely rapid, superluminal expansion, which must have turned it uniform and flat.

In 1998 there occurred a breakthrough concerning the nature of the universe, particularly related to the fact that its expansion seems to accelerate. The energy associated with the acceleration represents a mystery (since it cannot be detected directly). This energy is the so-called dark energy, which is hidden in the cosmic void.

John Wheeler noted information to be a fundamental feature of the universe, present throughout space and time and at the

same time everywhere. This led Einstein to say: The ancients apparently knew something that we have since forgotten.

There is an incomplete interpretation of the relationship between energy and the speed of light, according to which energy *converts* into mass, in keeping with the theory of relativity described by Einstein's well-known relationship ($E = mc^2$).

What should be emphasized is precisely the fact that the real aspect is not the transformation, but the *equivalence*, i.e. energy is not converted into mass, but rather *energy and mass are equivalent dimensions*. Mass becomes equivalent to *condensed or frozen energy*. *This approach leads to a first conclusion, concerning the universe, namely that the universe is created in accordance with physical principles centered on consistent constants of equivalence, and any change in these constants will finally result in a completely different universe.*

The immediate consequence is a brief listing of a set of stunning universal constants of today's physical universe, with simple references like the coefficient of friction, the general gas constant, Boltzmann constant, the constant of elasticity, the constants designated by analysis of density, electrical resistivity, viscousness, magnetic permeability, specific heat, caloric capacity, or references to more complicated phenomena of major impact, such as the constants related to the speed of light, gravitational acceleration, the specific load of the electron, the wavelength for sound and radiation, etc. Constants also become the specific ways of thinking, or physical approach to the universe, from determinism to materiality and predictability. Universal and absolute constants are purely mental in nature, thus exemplifying, with quantum physics, a process in the expression centred on energy and unpredictability. Newton's physics defines a universe at the limit of light speed, the universe of relativity or of relativism universe lies beyond the speed of light, and quantum mechanics lies beyond 6×10^{34}, or Planck's constant, etc.

A new hypothesis inferentiates this logic in the spectrum of demography, in the core of economic, social and political systems, which are, actually and really, under the impact of the same laws of the physical universe. It will be requisite to briefly list some of these constants of a complex type, derived by extending physical thought and modelling into the space of demography, economics, social or political phenomena…

Fertility at 2.3, which generates a constant population in demography, becomes an essential milestone like other physical constants.

The Club of Rome identified and subsequently theorized, under the pressure of economic resources, the first universal constant that seems to be purely economic, though extracted from the physical world, which can ensure protection and sustainable development in the famous formulation: "zero growth."

The threshold of GDP and public debt in GDP deficit, in the economic theory of convergence (amounting to 60%, and 3%, respectively) are essential constants, benchmarks of a process of statistical and mathematical rigor similar to statistical physics, as measured by the statistical indicator of the *coefficient of variation of GDP level per capita*, and are quite frequently exploited in analyses of economic convergence, by expression supported by the standard deviation indicator resulting from the calculation similar to the classical algorithm of dispersion, and finally of the coefficient of variation:

$$\sigma_t = \frac{\sqrt{\frac{\sum_{i=1}^{n}(Y_{it} - \bar{Y}_t)^2}{n}}}{\bar{Y}_t} \qquad (1)$$

The homogeneity threshold of the analyses of the qualitative variables or the alternative type of attribute variables (which are binary, and frequently expressed in marketing analyses as yes or not) generates a constant of market diversification in Pareto's optimum, expressed in an extended and approximate manner as 20/80, remains detached from the relationship:

$$\mathbf{Co} = \frac{\sqrt{p(1-p)}}{p} = 40\% \qquad (2)$$

(the correct and detailed solution determined being 0.14/0.86 or 14/86).

Capitalizing on the Gini–Struck coefficient (GS) and Hirschman coefficient (H) in curve ABC provides other constants, which are more extensive as impact and use of concentration and diversification in economic, social and political structural processes.

Introducing coefficients of the Gini–Struck (GS) and Hirschman (H) type [9] in ABC curve, determined following relations:

$$\mathbf{G-S} = \sqrt{\frac{n\sum_{i=1}^{n} g_i^2 - 1}{n-1}} \qquad (3)$$

$$\mathbf{H} = \sqrt{\sum_{i=1}^{n} g_i^2} \qquad (4)$$

where g is the internal structures specific to the processes analysed in the micro-economic, social and political universe, and n is the number of structures, typologies or groups composing it. The constants of excessive concentration and excessive diversification [10;11] are thus differentiated instrumentally:

The approximate values of the limiting instrumental constants in excessively concentrated or diversified phenomena

Table no.2

Limits of the indicator	Excessively concentrated markets	Excessively diversified markets
Gini-Struck coefficient	0.409	0.0
Herfindahl-Hirschman coefficient	0.667	0.557

Source: Săvoiu, Gheorghe, Crăciuneanu, Viorel, Iorga Simăn Ion, Dinu, Vasile 2012. *Taxes in Post–Accession Romania: Concetration and Specialization in the State Budget and Local Budget.* Economic Computation and Economic Cybernetics Studies and Research, Vol. 46, No. 4/201, pp. 143-161

Another phenomenon that is subject to the same universal constants is economic inflation, where peaks 3 to 5 percentages are considered significant initially, but later they are re-accommodated to the phenomena of convergence by limiting constants in the bands expressed with a harmonized and negotiated support under the Treaty of Maastricht, and also depending on criteria such as *inflation* (IM3 + 1.5 p.p., where IM3 is the average inflation of the three EU member states that have the lowest inflation, etc.). These few apparently minor examples show the latent and potential

capacity of econophysics, sociophysics, or even demographysics to shape ever newer solutions and scaling of processes and phenomena in the external universe through the agency of truly universal constants having a predominant role of equivalence.

4. SOME FINAL REMARKS

In a historical approach, the idea of cause was related to the idea of human will, often exemplified in economics through economic laws, decisions or solutions, which belong to individuals from the general area of humanity, and have generated immediate or delayed effects. A cause, no less than human will, is always considered active, in contrast to effects, which are continuously redefined as passive.

As an immediate consequence, an active cause and a passive effect require capitalization of prediction or forecasting assumptions. In classical physics, this kind of approach to causes and their effects is considered today as both anthropomorphic and unscientific, physics being redefined descriptively, in an attempt to practically describe how certain things happen.

In a historical approach, the idea of cause was related to the idea of human will, often exemplified in economics through economic laws, decisions or solutions, which belong to individuals from the general area of humanity, and have generated immediate or delayed effects. Causes, no less than human will, are always considered active, in contrast to effects, which are continuously redefined as passive. As an immediate consequence, an active cause and a passive effect require capitalization of prediction or forecasting assumptions. In classical physics, this kind of approach to causes and their effects is considered today as both anthropomorphic and unscientific, physics being redefined descriptively, in an attempt to practically describe how certain things happen.

In the real world, a cause defined solely by the will hidden behind the cause (a falsely volitional cause) has nothing to do with the effect.

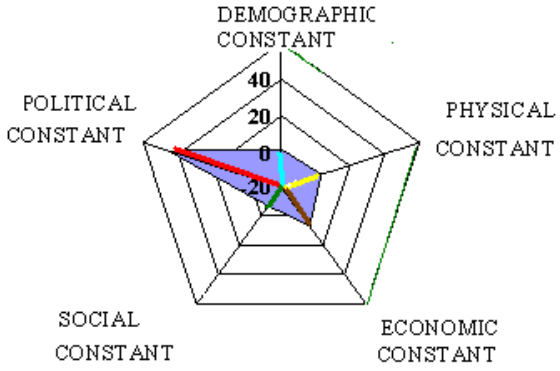
Any cause, when addressed physically, has to be reconceptualised as a set of events, either compensated or uncompensated, with connections or quantitative interrelations that are certain (which occurs rarely), or probabilistically known (more commonly), but not completely uncertain (which occurs very rarely), with a unique event analysed (in keeping with the *caeteris paribus* principle, which simplifies the act of knowledge of reality, although in reality many more items coexist).

Addressed from restrictive positions, the finality and uniqueness of the effect become rather a methodological preference, and a second artificialization considers cause as prior to the effect (although the effect can also be causally prior to, or concurrent, to complete the space and time of research or physical knowledge in economics or econophysics). Lightning, as cause, and thunder, as affect, are an extremely simplified causal example, which is however more easily perceived.

Complexity, compensation and decompensation are also natural explanations of the causal manifestations which mostly go beyond determinism and probabilistic thinking, belonging to indeterminism and appropriate causal risk, or risk of occurrence of the expected effect, although the strict, definite law of, as an originally philosophical rather than logical product, remains an ideal even under reconsideration, as essential truth, of the fact that "certain constant relations (or simply constants) always occur in the universe known to the human being, at time points determined among the members of a group of manifestations (or in a human population)…" [11]

Another solution that is becoming more probable, being validated even in some complex contemporary analyses of the multidisciplinary type [13], will become that of the system of constant combined into the concept of universal multiconstant, in accordance with the graphical model described in Figure 1

A graphical synopsis of a universal multiconstant
Figure no. 1



No doubt time deteriorates the constants identified, but even when these relationships are not proven, there instantly occurs the discovery of new relation, or new constants of even more extended impact…

Certainly there are many other constants, some more exciting than others, or perhaps much more interesting through their intrinsic beauty, but in the universe that could generate them man and humanity, or even planet Earth, may no longer exist, if the warnings of the current universal constant are not properly interpreted.

Perhaps a careful analysis of the physical constants in the physical universe may be a beneficial approach to both finding a solution for the reunification of the theory of relativity and quantum physics theory, as a table of universal physical constants such as the one conceived by Mendeleev constitutes a new beginning for creative resynthesizing. And, further on, an inferentiation of universal constants in the space of economics, demography, social and even political issues, can turn a seeming state of chaos into a long-awaited order...

REFERENCES

[1] Russel, B., (1914), *Our Knowledge of the External World as a Field for Scientific Method in Philosophy*, Ed. Routledge, Reed. in 1996, Bertrand Russel Peace Foundation Ltd.
[2] Piatkowski, A., Banu I., (coord), (1979), *Filosofia greacă până la Platon,* Ed. Ştiinţifică şi enciclopedică, Bucureşti.
[3] Leibniz. G. W., (1875 -1890), *Philosophische Werke*, in 7 vol., Ed Gerhardt. Vol I, p. 338.
[4] Hegel, G. W. F., (1970), Werke, Suhrkamp Verlag, vol XIII, p. 294
[5] Galilei, G., (1961), *Dialoguri asupra ştiinţelor noi*, Ed. Academiei RPR, Bucureşti, pp. 127-129.
[6] Frege, Gottlob (1903), *Grungesetz der Arithmetik* In Michael Beaney, (ed.), Frege Reader. Blackwell, Oxford, 1893/1997 vol I & Blackwell, Oxford, 1903/1997, vol II.
[7] Russel, B., (1914), *Our Knowledge of the External World as a Field for Scientific Method in Philosophy*, Ed. Routledge, Reed. in 1996, Bertrand Russel Peace Foundation Ltd. p.216
[8] Drăgănescu, M. (1985), *Ortophysics*, Ed stiinţifică şi enciclopedică, Bucuresti, p. 27.
[9] Hirschman, A.O., (1943), *On Measures of Dispersion for a Finite Distribution.* Journal of the American Statistical Association, 38 (223), pp. 346-352.

[10] Săvoiu, G., Crăciuneanu, V. Țaicu, M., (2010), *A New Method of Statistical Analysis of Markets' Concentration or Diversification,* Romanian Statistical Review, 58(2), pp.15-27.
[11] Săvoiu, G., Crăciuneanu, V., Iorga Simăn I., Dinu, V. (2012). *Taxes in Post – Accession Romania: Concetration and Specialization in the State Budget and Local Budget*. Economic Computation and Economic Cybernetics Studies and Research, Vol. 46, No. 4/201, pp. 143-161.
[12] Russel, B., (1914), *Our Knowledge of the External World as a Field for Scientific Method in Philosophy*, Ed. Routledge, Reed. in 1996, Bertrand Russel Peace Foundation Ltd. p.233.
[13] Săvoiu, G., (2008), *The scientific way of thinking in statistics, statistical physics and quantum mechanics*. Romanian Statistical Review, 56(11), SXIII, pp. 13-23.

FEAR, RUMOUR AND FASHION DYNAMICS SEEN AS SECOND ORDER PHASE TRANSITIONS

Mircea Gligor

National College "Roman Voda", Roman-5550, Neamt, e-mail: mrgligor@yahoo.com

Abstract. *The aim of the paper is to demonstrate that some methods taken from the statistical thermodynamics may be applied in order to model several social phenomena for which, for the time being, we have qualitative descriptions only. Some limitations and warnings related to the interdisciplinary transfer of concepts between physics and socioeconomic sciences are briefly analysed in the Introduction. In the second section we study the fear/rumour propagation process in the stock market space. The speculative bubbles are seen as non-equilibrium patterns resulted from the reaction-diffusion mechanism. In the third section we study the fashion fluctuations, seeing them as noise induced transitions in a system in which the interaction among individuals is described by means of the classical Ising-spin model. In spite of several unavoidable limitations, the models offer useful quantitative explanations to the phenomena and fit well the empirical data.*

Keywords: *small-world network, minimal path length, clustering coefficient, phase transition*

1. INTRODUCTION

Actually, sociologists seem not to show great interest in the sociophysics itself and thereby sometimes this activity is quoted with ironical comments, as "reinventing the wheel". Nonetheless, more and more sociologists notice the activity of the physicists on social networks, and the new methods of solving some classical problems of sociology such as the small world problem, the information and contamination spreading in various networks, the preferential attachment, and so on. We note here that the leading authors in sociophysics, such as Serge Galam, Dietrich Stauffer, Janus Holyst and others published some of their early work in sociology journals. Also, they paid much attention to references to sociological and psychological literature.

If some agreement is possible between the sociologists and the physicists, it is probably about the need of a more intense exchange of information [1]. For example, many sociologists know about the physics of the networks, but they are less informed about the fact that many more methods of the statistical mechanics were succesfully applied in the study of the human collectivities. It would be worth mentioning here the self-organization in complex systems, the Ising-like models, and the quantum theory. Even if the results tend to be more in the form of general theorems and bonds than specific results for particular problems, they are attracting growing interest, especially for the new viewpoints they generate for old questions.

Some inherent difficulties of such an undertaking are pointed out in [2]. Modeling dependence in the social sciences has to take into account circumstances that differ substantially from those encountered in the natural sciences. Firstly, experimentation is usually not feasible and is replaced by survey research, implying that the explanatory variables cannot be manipulated and fixed by the researcher. Secondly, the number of possible explanatory variables is often quite large, unlike the small number of carefully chosen treatment variables frequently found in the natural sciences.

To begin with, let us analyse four basic concepts as taken from the statistical mechanics to describe social systems: spins, interaction, temperature and phase transition.

a) *Spins and opinions*

In social sciences the term opinion is not yet very precise. In sociophysics we represent opinions by spins. A spin is a variable assigned to an actor or agent. There is usually a large set of agents i, distributed in lattice sites or graph nodes; then, we have spin variable si. As a rule, in the sociophysical papers, spins can be of two values, +1 or ¯1, but the spin variable has been generalized to capture the situations when we have more than two opinions. The spectrum of possibilities is either discrete or continuous. In both cases we can also look for magnetic analogies; the respective models are the Potts model [4] and the classical Heisenberg model [3] reduced to one variable. Multidimensional approach was already used (see e.g. [5], [6]), and presumably will be used in many other papers.

b) *Interaction*

In physics, the only way for an object to exist is to have energy: a possibility of doing work. In social sciences, there is nothing like energy: no energy conservation, no energy measurement. In physics, the way to detect the interaction between objects is to observe correlations between their states. In this sense, physical interaction is detectable also in sociology. In sociology, one speaks about four levels of theoretical description of interpersonal interactions [1]. At the first level, the interaction is described as a chain of impulses and reactions. At the second level, interaction is undersood as social exchange. The above-mentioned concept of reciprocity applies correctly here. At the third level, meanings of interactions are as exchange of information by means of human contacts. At the last level of abstraction, we find the theory of social roles and labeling. In sociophysics, most of these subtleties are lost. Within the magnetic analogy, the interaction between partners is reduced to the energy of a mutual interaction.

c) *Temperature and noise*

In physics, temperature is inseparably connected with energy. In thermal equilibrium the probability of appearance of a given state depends on the ratio E/T, where E is the energy of this state. As noted above, there is no energy in social

sciences; then it seems that the temperature cannot be present there. However, there is also a more general view on temperature: we often refer to "social temperature" as a measure of the degree of randomness in agent decision-making.

d) *Phase transition*

What a sociophysicist likes most to obtain is a phase transition. The reason is that he knows that social theories are qualitative. A change of phase, as for example a revolution or a paradigm shift, should be perceptible in a society even without measurements.

For the social systems, the time series are often short and noisy. Most social data have a quarterly or at most monthly frequency. When social time series have been produced for a very long period, there is usually strong evidence against stationarity. It is all the more interesting to notice that at given times such series exhibit a behavior like that of the power laws. The interest in searching power laws in the description of complex, collective phenomena is caused by the fact that these power laws are universal, that is to a large degree independent of the microscopic details of the phenomenon. As such, they are typical features of a collective mechanism like the phase transitions: many observables behave as universal power laws in the vicinity of the transition point [3]. Also, the interest in power laws is related to an important property of power laws, namely scale invariance: the characteristic length scale of a physical system at its critical point is infinite, leading to self-similar, scale-free fluctuations. Long ago, physicists noted, in several contexts, the possibility of a „critical state", in which independent microscopic fluctuations can propagate so as to give rise to instability on a macroscopic scale. This is a state in which chain reactions initiated by local disturbances neither damp out over a short distance (the "subcritical case"), nor propagate explosively so that the system cannot remain in that state (the "supercritical case"). Often this has seemed to depend upon parameters being carefully "tuned" to their exact critical values.

However, theories of phase transitions demand some ingredients which are impossible to occur in the social world. First is the so-called *thermodynamic limit*: the transition is well defined only in infinite systems [7]. In an infinite system there is always a finite probability that the phase will be changed due to fluctuations of some uncontrollable quantities. This is particularly true in social reality, where each system has its finite lifetime; from hours for an electoral meeting or years for a stategic alliance among countries, to centuries for an empire. For some models of relevance in the social sciences the system size plays an important role in the final outcome of the dynamics. Some changes of behaviour can appear when the number of agents in the model takes a finite value. Those changes of behaviour can be related to the apparent phase transitions that appear in some physical models. However, the effects can be meaningful in social sciences.

Here we must note another problem, connected with the previous one: the condition of equilibrium. In physics, the notion of equilibrium, although only intuitive, is well established. In a social system, equilibrium is never attained. Some correspondence to this difficulty exists also in statistical physics, for example in the theory of spin glasses. In such cases, one usually intends to assume that there are two kinds of processes: very quick, and those are over before an experiment started, and very slow, and those do not change.

Taking into account the above considerations we can conclude that sociophysics will never substitute sociology. What econophysicists and sociphysicists can do best is to give quantitative "clothes" to some rather qualitative conceps from social sciences, but, of course, these clothes may be too tight or too loose. The test of validity of the model apropriateness is always the agreement with the empirical data and the ability of leading to correct predictions. In the next sections we will try to model some qualitative phenomena such as fear/rumour propagation and fashion fluctuations by means of some methods taken from statistical thermodinamics, namely the reaction-diffusion mechanism (Section 2), Ising-spin models and noise induced phase transitions (Section 3). Some concluding remarks are drawn out in the last section.

2. FEAR AND RUMOURS: NON-EQUILIBRIUM PATTERNS IN THE STOCK MARKET SPACE

2.1 *The concept of rumour*

The subject of rumour formation is getting strategic importance at all levels of society. Control and possible handling intended to manipulate information are now major issues in social organizations including economy, politics, defense, fashion, and even personal affairs. Especially with the existence of Internet, which provides a support to anybody to say anything, and then consequently to be possibly heard by millions of people. To be read can imply to be automatically perceived like truth, and retransmitted as such to others.

However, information shared by a very great number of people does not obviously prove its authenticity by anything. Still, it can induce quite concrete and sometimes dangerous follow up acts. It may also happen that once a point of view on some specific issue has been widely adopted, the presentation of objective facts proving its falseness, does not produce the abandonment of this same false point of view. By contrast, a rumour can prove to be true while at first set, false by official media. The frontier between a rumour and information turns out to be very fragile.

An interesting analysis of rumour formation may be found in one of S. Galam's papers [8] in relation to the astonishing wide adhesion of French people to the rumour claiming "No plane did crash on the Pentagon on September the 11". In this paper a generic explanation is given, in terms of a model of minority opinion spreading. Using a majority rule reaction-diffusion dynamics, a rumour is shown to invade for sure a social group provided it fulfills simultaneously two criteria. First, it must be initiated with a support beyond some critical threshold which, however, turns out to be always very low. Then it has to be consistent with some large collective social paradigms of the group.

The dynamics of the rumour processes that take place both in small-world networks and in complex heterogeneous networks has been intensively studied in the literature of the last fifteen years (see some starting points in [9] and [10]). It was demonstrated that the propagation of a rumour on a network exhibits critical behaviour at a finite randomness of the underlying graph. The transition occurs between a regime where the rumor "dies" in a small neighborhood of its origin, and a regime where it spreads over a finite fraction of the whole population.

Now let us have a look at how markets and securities may react to news and rumors. Fortunes change fast in the stock market – so, it is critical for investors to stay abreast of investment news in addition to stock quotes and charts. As we

saw in the fall of 2008, financial services stocks were hammered, sometimes on the basis of market news alone [11]. There are arguably no better examples of how investment news can impact stock prices than the recent crisis in financial services stocks. Here are a few examples: On September 11, 2008 Lehman Brothers (LEH) announced it was actively seeking a buyer. Right after the announcement, its shares plummeted 45%. What happened in fact? Lehman's announcement made it clear they were having troubles finding a suitor. Having to advertise your willingness to be bought is not usually considered a bullyish signal. True to expectations, on September 15 Lehman filed for bankruptcy, the largest bankruptcy in U.S. history.

In the same week, insurer American International Group (AIG) began admitting that its balance sheets were similarly threatened by the subprime mortgage crisis. Between September 10 and September 16, when the government announced a feverishly constructed rescue plan for the insurer, AIG's stock plunged about 80%.

You can see the rise and fall of hope versus fear in XLF, the Exchange-Traded Fund (ETF) tracking the financial services industry. After the U.S. government made an announcement on its bailout package, the ETF bounced up and down accordingly. When the first bailout package was rejected by Congress in late September, the bad news meant bad news for stock prices in the financial sector, too – the XLF dropped almost half its value as investors waited impatiently for the verdict from Congress. When a revised bailout package finally passed, the market news perked up as well, stabilizing XLF.

A curious fact – and one that is crucial to understanding stock prices – is that good news does not always translate to a jump in stock price; in fact, often the good news will produce a slight drop in a stock price. That happens because unofficial news, also known as "rumors", can have as much impact on stock prices as official news announcements. The stock market often anticipates these news stories and "prices in" its expectations accordingly. When those expectations are confirmed with actual investment news, the price may temporarily drop. Of course, the reverse applies, too: if rumors swirling around a stock are not proven true, investors may respond in surprising ways. If the surprise is a good one, stock prices can be driven upward as a result. That is why it is key to watch the investment news online and see how headlines influence stock quotes.

2.2 *Reaction-diffusion processes in the stock market space*

Here we propose macroscopic modelling of the formation of patterns (or "dissipative structures") in the one-dimensional space of the prices on the interdealer broker markets). In the framework of the chemical model which we develop, the stocks of the shareholders A and B will be called α and β respectively, and have the role of the chemical concentrations. We call ϕ the spectral density of the intermediated transactions (i.e. the number of the transactions per unit of price). The quantity ϕ has here the significance of the concentration of the intermediate product *X*. With these notations, the financial brokerage mechanism can be writing formally:

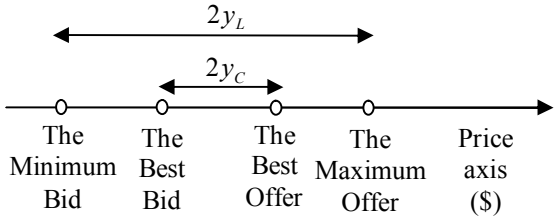
$$A \underset{k_1'}{\overset{k_1}{\rightleftarrows}} X; \quad X \underset{k_2'}{\overset{k_2}{\rightleftarrows}} B, \qquad (1)$$

The mechanism described by (1) allows us to use a phenomenological approach ([12]).

We focus on the dependence of ϕ of the bid-offer spread (we use here this notion as it has been defined in [13]). The bid-offer spread is done as:

y = (offer price) – (bid price).

In order to clarify some quantities that we use, it is worth to have in mind the one-dimensional representation:



Making a suitable change of the variables, we can set the extreme values of the spread symmetrical with respect to the origin of the prices axis:

$$-y_L \le y \le y_L \qquad (2)$$

The spectral density of the transactions will satisfy the Dirichlet boundary conditions:

$$\phi(-y_L) = \phi(y_L) = 0 \qquad (3)$$

The financial brokerage between A and B unfolds in accordance with the mechanism described through Eq. (l) only if the spread is framed by certain limits related to:

Best Spread ($2y_C$) = (Best Offer) – (Best Bid), that is:

$$-y_C \le y \le y_C, \qquad (4)$$

where $y_C < y_L$.

For: $-y_L \le y \le -y_C$ and $y_C \le y \le y_L$, the spectral density of transactions becomes less than a critical value ϕ_C, involving the reduction of the brokerage mechanism to the form [14]:

$$A \underset{k_1'}{\longleftarrow} X; \; X \underset{k_2}{\longrightarrow} B \qquad (5)$$

This mechanism reflects the fact that when the spectral density of transactions decreases (which implies, in financial language, a higher "volatility" of prices), the shareholders retire their assets from respective market.

According to the chemical reactions theory, taking into account both the first and the second mechanism, the deal rate will be:

$$\frac{\partial \phi}{\partial t} = k_1\alpha - k_1'\phi - k_2\phi + k_2'\beta, \quad \phi \ge \phi_C$$

$$\frac{\partial \phi}{\partial t} = -k_1'\phi - k_2\phi, \quad \phi \le \phi_C.$$

Conveniently scaling:

$$\frac{\partial \phi}{\partial t} = -\phi + \phi_h\theta(\phi - \phi_C), \qquad (6)$$

where θ is the step Heaviside function.

This picture has become very useful in the description of pattern formation and propagation in the active (excitable) media. A distributed active medium can be viewed as a set of active elements, the traders, each element being a system with two or more possible steady states (e.g., selling

/buying/waiting), representing small parts of a continuous system, interacting among each other through trading. We assume that the interactions between the different elements that compose the active medium are local in time and also that the variation in space is not too extreme. This implies that we can neglect the memory effects, as well as the space derivatives of order higher than two. Within the formalism of the reaction-diffusion model the general form of the macroscopic equation for the case of only one relevant macroscopic variable ϕ will then be:

$$\frac{\partial\phi}{\partial t} = F\left(\phi, \frac{\partial\phi}{\partial y}, \frac{\partial^2\phi}{\partial y^2}, \ldots\right)$$

Expanding this in terms of the spatial derivatives, taking into account that the medium is isotropic and neglecting higher order derivatives, the equation reduces to:

$$\frac{\partial\phi}{\partial t} = F(\phi) + D\frac{\partial^2\phi}{\partial y^2} \qquad (7)$$

The first term on the r.h.s. of the Eq. (7) describes the behaviour within each cell corresponding to one of the active elements (usually called "the reactive part"), while the second corresponds to the interaction of the different cells with each other.

The development of the model follows the canonical procedure. First a suitable reference state ϕ_S which is an exact solution of the Eq. (7) is identified. The choice of ϕ_S is motivated by physical arguments. Typically ϕ_S is a state describing the "simplest" behaviour observed in the system – a quiet market, without crashes or large price variations. Within the same paragraph the stability of ϕ_S is tested against perturbations. The next paragraph includes a model describing the propagation of pattern in one-dimensional systems and a method for the experimental testing of the model.

2.3 *Pattern Formation. The Stability of Steady-State Solutions*

The first step is to look for stationary solutions, which are to consider $\frac{\partial\phi}{\partial t} = 0$. Eq. (7) reduces to:

$$D\frac{\partial^2\phi_S}{\partial y^2} + F(\phi_S) = 0 \qquad (8)$$

(For simplicity, we will drop the index of ϕ_S where no confusion is possible).

For the one-dimensional problem considered, the reactive term (or the "force" $F(\phi)$ can always be derived from a potential $V(\phi)$, according to:

$$F(\phi) = \frac{d}{d\phi}V(\phi) \qquad (9)$$

Taking into account Eq. (6), the stationary equation for our model will be:

$$\frac{d^2}{dy^2}\phi(y) - \phi(y) + \phi_h\theta[\phi(y) - \phi_C] = 0, \qquad (10a)$$ or:

$$\frac{d^2}{dy^2}\phi(y) + \frac{d}{d\phi}V(\phi) = 0, \qquad (10b)$$

where:

$$V(\phi) = \int F(\phi')d\phi' = \begin{cases} -\frac{1}{2}\phi^2 & \text{for } \phi \le \phi_C \\ V_h - \frac{1}{2}(\phi - \phi_h)^2 & \text{for } \phi \ge \phi_C \end{cases}$$

with: $V_h = (1/2)\phi_h^2 Z$; $Z = 1 - 2\phi_C/\phi_h$. (11)

To find the form of the stationary solutions, one may distinguish two different regions:

1) The regions of "cold" deals (non-speculative transactions), where $\phi(y) \le \phi_C$, and Eq. (10) reduces to:

$$\frac{d^2}{dy^2}\phi(y) - \phi(y) = 0 \qquad (12a)$$

with solutions having the general form:

$\phi(y) = A_C\exp(y) + B_C\exp(-y)$;

2) The regions of "hot" deals (speculative transactions), where $\phi(y) \ge \phi_C$, and Eq.(10) becomes:

$$\frac{d^2}{dy^2}\phi(y) - \phi(y) + \phi_C = 0 \qquad (12b)$$

with general solutions of the form:

$\phi(y) = A_h\exp(y) + B_h\exp(-y) + \phi_h$.

Imposing the Dirichlet boundary conditions (3), we get the analytical steady-state solution:

$$\phi_S(y) = \phi_h \begin{cases} \dfrac{\sinh(y_C)\sinh(y_L + y)}{\cosh(y_L)} & \text{for } y \in [-y_L; -y_C] \\ 1 - \dfrac{\cosh(y)\cosh(y_L - y_C)}{\cosh(y_L)} & \text{for } y \in [-y_C; y_C] \\ \dfrac{\sinh(y_C)\sinh(y_L - y)}{\cosh(y_L)} & \text{for } y \in [y_C; y_L] \end{cases}$$

The points $\pm y_C$ are determined by the matching conditions at $y = \pm y_C$, $\phi_S = \phi_C$, resulting:

$$y_C^{\pm} = \frac{1}{2}y_L + \frac{1}{2}\ln\left[Z\cosh(y_L) \pm \sqrt{Z^2\cosh^2(y_L) - 1}\right] \qquad (14)$$

Note the possibility of existence of two solutions, which are two possible roots $y_C^{\pm}$ depending on the value of *Z*.

We can now analyse the stability of the structures that we have found, adding to ϕ_S a small perturbation:

$$\phi(y,t) = \phi_S(y) + \varphi(y,t) \qquad (15)$$

Substituting this into Eq. (10) and linearizing in $\varphi(y,t)$, we obtain:

$$\frac{\partial}{\partial t}\phi(y,t) = \left[\frac{d^2}{dy^2}\phi_S(y) - \phi_S(y) + \phi_h\theta(\phi_S(y) - \phi_C)\right] + \frac{\partial^2}{\partial y^2}\phi(y,t) - \phi(y,t) - K\sum_j \delta(y - y_j)\phi(y,t) \qquad (16)$$

The term within the large parentheses is zero, as it must be from the stationary condition, reducing Eq. (16) to an equation for $\phi(y,t)$. The parameter *K* arises from the discontinuities

(due to the presence of the step $\theta(y)$ function) at

$y_j = \pm y_C$,

and is given by:

$$K^{\pm} = \phi_h \left| \frac{d\phi_S(y)}{dy} \right|^{-1}_{y=y_C^{\pm}} = \frac{\cosh(y_L)}{\sinh(y_C^{\pm})\cos(y_L - y_C^{\pm})} \quad (17)$$

We further propose:

$\varphi(y,t) = \varphi_0(y)\exp(-\gamma t)$, (18a)

leading in each region to solutions of the form:

$\varphi_0(y) = a\exp(\lambda y) + b\exp(-\lambda y)$. (18b)

Replacing Eqs.(18) into the equation for $\varphi(y)$, we find:

$\gamma = 1 - \lambda^2$. (19)

The coefficients *a* and *b* from (18b) depend on the region and they are determined through the same boundary conditions as for the stationary solutions (13). Without loss of generality, we can choose $y_L = 1$;

The form of the perturbation (for $y > 0$) will be:

$$\varphi_0(y) = \phi_h \begin{cases} 1 - \dfrac{\cosh(\lambda y)\cosh[\lambda(1-y)]}{\cosh(\lambda)}, \\ \qquad \text{for } 0 < y < y_C; \\ \dfrac{\sinh(\lambda y_C)\sinh[\lambda(1-y_C)]}{\cosh(\lambda)}, \\ \qquad \text{for } y_C < y < y_L. \end{cases} \quad (20)$$

There are many ways to study the connection between the eigenvalue λ and the value of y_C. The simplest is by imposing the natural requirement: $\varphi_0(0) << \phi_S(0)$ which leads to:

$$\frac{\cosh[\lambda(1-y_C)]}{\cosh(\lambda)} >> \frac{\cosh(1-y_C)}{\cosh(1)}.$$

At the limit $y_C \to 1$, the inequality is fulfilled when $\lambda << 1$ (i.e. $\gamma > 0$), indicating that the corresponding stationary solution (with the larger dissipation) is stable. For small values of y_C (at the limit $y_C \to 0$) we find $\varphi_0(0) \geq \phi_S(0)$. The corresponding solution (with the sign "-"in Eq.(14)) is unstable.

2.4 *Some Extensions: Pattern Propagation*

An important property of the patterns is the space-time propagation described by the solution of Eq.(7) in its complete form. Some results can be obtained taking over a particular kind of solutions such as the *solitary waves* ([**3**]). We will give further a briefly discussion about the theoretical approach of the phenomenon.

The solitary waves are functions of the spatial (*y*) and temporal (*t*) coordinates, not independently, but through the combination:

$\xi = y - ct$. (21)

In terms of the new variable ξ , Eq. (6) adopts the form:

$$\frac{\partial^2}{\partial \xi^2}\phi(\xi) + c\frac{\partial}{\partial \xi}\phi(\xi) - \phi(\xi) + \phi_h\theta[\phi(\xi) - \phi_C] = 0 \quad (22)$$

Let us concentrate on the situation where the potential $V(\phi)$ has a bistable form as it is given by Eq. (11), and solve Eq. (22) with the boundary conditions:

$\phi \to 0$, for $\xi \to -\infty$ (23a)

$\phi \to \phi_h$, for $\xi \to \infty$ (23b)

The resulting wave, or moving pattern, is called a *trigger wave* (or *front*), because its propagation triggers the transition from one stationary state of the system (say $\phi = 0$) to the other (say $\phi = \phi_h$). This kind of waves has been observed, for instance, in chemically reacting media or as electrical activity that propagates along the axonal membrane [12]. There is a point $\xi = \xi_C$, at which $\phi(\xi_C) = \phi_C$. Due to translation symmetry, we can choose, without loss of generality, $\xi_C = 0$. The form of the solutions is:

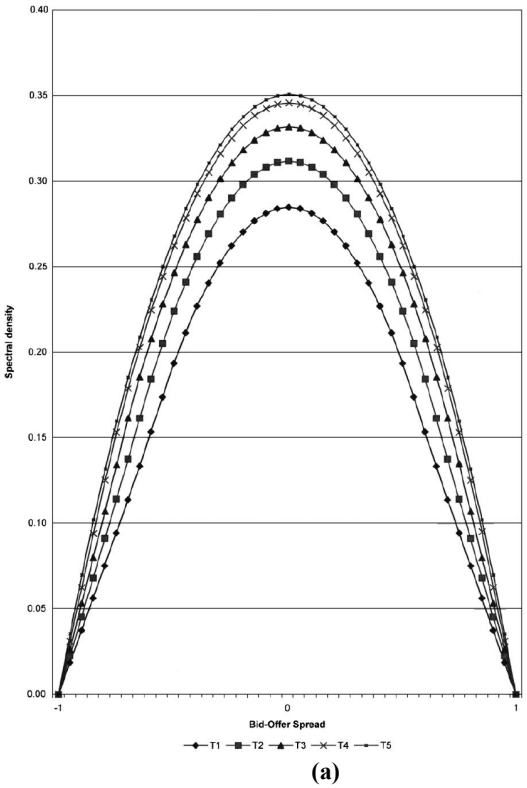
$$\phi(\xi) = \begin{cases} \phi_C \exp(\omega\xi), & \text{for } \xi < 0; \\ (\phi_C - \phi_h)\exp(\omega\xi) + \phi_h, & \text{for } \xi > 0, \end{cases} \quad (24)$$

where: $\omega_{1,2} = -\frac{c}{2} \pm \sqrt{1 + \frac{c^2}{4}}$. (25)

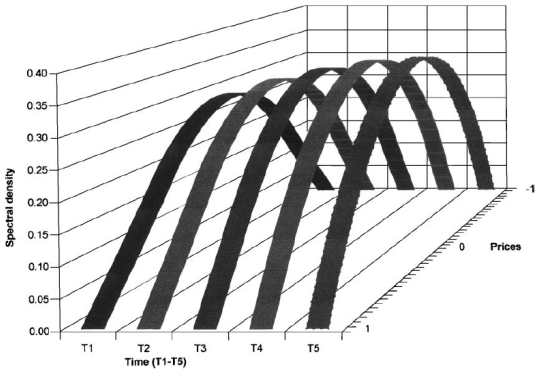
The propagation velocity c can be related to:

$$\Delta V = \int_0^{\phi_h} F(\phi')d\phi' = \frac{1}{2}\phi_h(\phi_h - 2\phi_C) \quad (26)$$

The correspondence between the two quantities is based on the interpretation of Eq. (22) as the movement equation of a particle in the force field $F(\phi)$ derived from the potential $V(\phi)$; In such an analogy ϕ is the spatial coordinate and *c* plays the role of the friction coefficient. The sign of ΔV is related to the sense of movement on the axis (Figure 1). For $\Delta V = 0$, ($\phi_h = 2\phi_C$), the velocity is zero, and there is no propagation.



(a)



(b)

FIGURE 1 a) A plane representation of the patterns ("speculative bubbles") in the 1-dimensional space of stock market prices. The curves represent the spectral density of transaction (number of transaction per unit of price) f, plotted depending on the bid-offer spread y, in accordance with Eq. (13), for different trading days [14]. **b)** A spatial representation of the patterns. One can see the time propagation.

Finally, the model developed in this section describes the stock market speculative bubbles as thermodynamic instabilities and treats them in the reaction-diffusion formalism. Although any essay of this kind is to a certain extent speculative, it could provide an alternative way to explore some complex economic phenomena, leading to the possibility of some predictions, which are potentially useful for the practitioners in the financial field.

In order to shed more light on the mechanisms described by Eq. (1) and Eq. (5), let us consider the following situation: the investor *A* needs money to extend his business and offers shares (stocks), while the investor *B* wants to invest money profitably. The both will appeal to the stock market, where their transaction will be intermediated by the broker *X*. The difference between the selling price (offer) and the buying price (bid) is the broker's premium usually called bid-offer spread, y. This is the general framework modelled by Eq. (1). Note that to a large extent our model is "minimal": in the real stock markets there are many brokers (or brokerage firms) and a huge number of stocks is traded each moment so that, at least for y and ϕ, a statistical description is more adequately. In our thermodynamic framework, we take for granted this aspect. When the number of transactions becomes small, the market is – in financial terms – without liquidity. For a while the broker will pay *his own* money to *A* and will sell to *B* shares from *his own* stock. Essentially, this is the meaning of the mechanism described by Eq. (5). Our model associates with such situations critical values of density, ϕ_c, and bid-offer spread, y_c.

A speculative bubble occurs when, as a reaction to various rumours, the large majority of certain stocks are bought in order to be resold later on, exceeding to a large extent their underlying value. The famous economist John Maynard Keynes used "the beauty contest" as a parable describing such situations: In order to predict the winner of a beauty contest, objective beauty is not much important, but knowledge or prediction of others' predictions of beauty is much more relevant. Speculative bubbles disappear gradually or collapse unexpectedly generating financial crashes.

3. MODELLING FASHION: SPIN MODELS AND PHASE TRANSITION

3.1 *The concept of fashion*

"Fashions have changed", "in fashion", "old-fashioned" are phrases frequently used in the street, on TV or in newspapers. But what fashion are we talking about? The fashion of ideas, artistic fashion or, more prosaically, dress fashion? When we talk about fashion, do we consider it to be the result of a creative process (either intellectual or industrial), or a method of communicating a certain "way of life" which would correspond in economics to the level of information? The simplest way to understand the fashion is postulated in early sociophysics literature [15]: every time a new outlet appears on the market, it can, under certain specific conditions, invade the market. Each creator competes for a finite population of agents. Hence, the "old" outlet can be completely dominated and disappears.

The word fashion (or *mode*) originates in the Latin word *modus*. *Modus* means the non-existing limit. Its equivalent in the English language is *fashion* and means "method, form, style, mode; behavior, lifestyle of the gentle class, and upper class". In Romania, *moda* first came into use once with Westernization, and developed mostly under the influence of French culture. The reason for this was, partly, the dominance of French culture in the social and governmental life of the Ottomans.

It is possible to divide fashion in the sense of temporary novelty in the social life into three groups [16]:

1- The temporary novelty with the need for a change and fancy in beautification, e.g. mini-skirt fashion

2- The social favor for a certain period of time, over keenness for an object

3- Objects fitting to the novelty and social favor temporarily, like the hat fashion.

As seen from the items above, fashion can change forms, as in item 1, or disappear, as in item 3.

Or else, fashion that that disappeared can be fashionable again after a certain period of time.

The general meaning of fashion is determined by the two antonyms, namely, the fashionable and the unfashionable. These terms indicate that some of the changes in social forms are more accepted and considered more as compared to others.

The word *fashion* recalls clothing in the first place. However, philosophy, art, music, house decoration and many social sciences also constitute components of fashion. Every changing area of the social life is open to the interest of fashion ([17]).

The common statement in the definitions of marketing developed by scientists is the "development of ideas of manufacture, and the production, pricing, adhering and distribution of the manufacture". Which manufacture(s) must be produced? In what quantity and for which consumer mass must it be produced?

Answers to these questions and the results of the investigations on other marketing components can help for making the required decisions. As is known, manufacture with a certain physical structure and servicing that is not manufacture have equal importance as regards the satisfaction of human needs.

FASHION, which plays and important role in the decisions of marketing, consists in product(s) (services) that the majority of consumers in the target market adopt the buying behaviour for reasons of prestige, personal satisfaction, gaining status, or similar reasons. Here, social psychology plays an important role rather than individuality, and if the fashionable products in the market are accepted as FASHION by the group of consumers in numbers exceeding the average,

others also follow the majority they accept as a reference standard [18].

When handling the concept of *fashion* as regards the marketing above, "fashion" can be created also in the other layers of the society following the opinion leaders along the axis of novelty.

The word "fashion" generally calls to mind clothing, in the first place, and it is the "woman" who uses fashion in the most efficient way possible. Therefore, wise operations develop their marketing strategies to create fashionable products to ensure profit maximization within a short time, because these products have the highest selling potential as long as they remain in the market.

The history of fashion starts with the history of humanity and continues with the transformation of dressing to a fact of being accepted beyond the need. Individuals have reflected the characteristics of the society they belong to, their personalities and lifestyles in their clothing. Very important changes in the area of fashion happened especially with the advent of the Industrial Revolution. Serious increases in the trade of clothing were seen in the late 1870s after the invention of the sewing machine in 1825 and the invention of the first synthetic dye in 1856. This became widespread throughout the world in the 1870s and serious increases were observed in the trade of clothing, and the prices of the clothes fell. [19]

Fashion pages in newspapers started to be common in 1850s, and the foundations of the expensive 'haute couture' made for the upper classes were established by the English fashion designer Charles Frederick Worth. Worth opened the first fashion house in Paris in 1857 and therefore the understanding of the nameless concept, which was women having their dresses designed by tailors, left its place to the understanding of presenting the fashion designers new collections for each season. With Worth, a "Fashion System" in the modern sense was established that was affordable for most people. The production of clothing for the elite that started in the workshops of Worth became to spread in many European cities [20]. Starting from the year 1871, paper dress patterns prepared by Ellen Butterick provided great ease for sewing. Following this, sewing the shoes also with sewing machine and mass production was started. Consumption of ready-made clothing started thus.

Liberalization seen in the world in recent years and particularly the collapse of the USSR and the free market economy has enlarged the alternative markets in the international markets and the operations entered a ruthless competition with domestic and foreign competitors in their own markets and in foreign markets. Following this, the global markets and global competition were introduced. The economic changes appearing as a result of political changes and particularly the stunning developments in information technologies have revealed the need for radical changes in all the functions and the understanding of management of operations.

Very much as in the movie industry or the industry of industrial design, fashion activity depends on the level of creativity of the designers. It also depends on the level of public recognition of this creativity. Nike certainly shares this assumption, paying Michael Jordan, the famous US basketball player, a stunning 20 million dollars in 1992, for endorsing Nike running shoes.

Fashion improves neither efficiency nor the marginal utility of the consumption. Clothes belong to a class of goods whose functional properties are fundamental in their consumption. It is easy to understand why I need to buy a dress, or a pair of jeans. It is harder to explain why I choose Adidas shoes, or Levi's jeans. Moreover, it seems very difficult for an economist to explain why women ask for short skirts one year, long skirts the year after, and then short skirts again the year after that. Some theoricians may talk of erratic preferences, but the desire to be in fashion could justify Janssen and Jager's argument [21] that "...in satisfying their need for identity, people may change their behaviour without changing their preferences".

3.2 *The Ising-spins modelling*

Firstly, let us review some basic features of the phase transitions. The processes of boiling-condensation, melting-freezing, and congelation-sublimation involve changes in entropy (S) and volume (V). According to Ehrenfest, such transitions are classed as changes of phase of the first kind (or the first order): whereas the Gibbs function remains constant during a change of phase, its first derivatives S and V change abruptly. A distinction of a phase change of the first kind is that the new phase is formed gradually: The fraction of the new phase gradually increases as more of the latent heat of the respective phase change is put into or withdrawn out of the system.

There exist phase changes of higher orders, in which S and V retain their values constant during a phase change. In the process T (temperature), p (pressure) and E (internal energy) likewise remain unchanged. If, during a phase change, c (the specific heat) and the other caloric coefficients are incremented or decremented by a finite amount, such phase transitions are called transitions of the second kind (or of the second order) because each of these quantities can be defined as a second derivative of the Gibbs function. An example is the transition from the state of superconductivity to the normal state in the absence of a magnetic field.

An example of a higher order phase change is the lambda phase change, so called because the $c = f(T)$ curve looks like the Greek letter "lambda" (Figure 1). Examples of the lambda phase change are the transition from the ferromagnetic to the paramagnetic state or from He I (the ordinary, viscous state of helium) to He II (a peculiar state called superfluid). The lambda transition proceeds without an abrupt change in density (the density curve has a quiet peak around the λ-point), without evolution or absorption of latent heat, and is accompanied by a sudden change in specific heat ([22]).

As has been shown in econophysics literature, there are many similarities between the physical complex systems and the collective behaviour of various groups of individuals. We may ask now about the key to these similarities. Our Ariadne's thread is that complex systems often reveal more of their structure and organization in highly stressed situations than in equilibrium. This point of view is influenced by the concept of criticality developed in statistical physics in the last four decades in order to describe a class of cooperative phenomena, such as magnetism and melting, and our hypothesis is that the group of individuals behaves as a many-body system driven out-of-equilibrium. In the next subsection we would like to defend the thesis that the crashes of some market shares have fundamentally similar origins, which must be found in the collective organization of the individuals leading to a regime known as a "critical" point.

As we have claimed in the previous subsection, a new fashion arises when a large group of individuals decide simultaneously to buy a certain product instead another one.

One curious fact is that the agents in this group typically do not know each other. They did not convene a meeting and decide to reject the old-fashioned product. Nor do they take orders from a leader. In fact, most of the time, these agents disagree with one another. The key question is: by what mechanism did they suddenly manage to organize a coordinated buy-off?

As in Ref. [22], we propose the following answer: all the individuals in the world are organized into a network (of family, friends, colleagues, etc.) and they influence each other *locally* through this network. Each of them is directly connected with γ nearest neighbours, and there are only two forces that influence his opinion:

(a) the opinions of these γ people;

(b) an idiosyncratic signal that he alone receives.

Our working assumption is that agents tend to *imitate* the opinions of their nearest neighbors, not contradict them. Clearly, the force (a) will tend to create order, while force (b) will tend to create disorder. The main story that we are telling on is the fight between order and disorder. As far as asset prices are concerned, a crash happens when order wins (every agent has the same opinion: selling), and normal times are when disorder wins (buyers and selling disagree with each other and roughly balance each other out). This is exactly the opposite of the popular characterization of crashes as time of chaos.

In our microscopic modelling we consider the traders network as an arrangement of N fixed points forming a n-dimensional periodic lattice (n = 1, 2, 3). At each site of this lattice is attached a number S_i , (i = 1,…,N), taking only two values: S_i = +1 (the spin "up"; selling option) and S_i = -1 (the spin "down"; buying option). A set of numbers $\{S_i\}$ specifies a configuration of the whole system. The energy corresponding to this configuration, in absence of external fields, is :

$$E_i = -\sum_{\{ij\}} \varepsilon_{ij} S_i S_j$$

where $\{ij\}$ appoints a pair of nearest spins and ε_{ij} is their interaction energy. Because $\{ij\}$ and $\{ji\}$ are not distinct, the sum will have $\gamma N/2$ terms, with γ being the number of nearest neighbours of a given spin.

Although the configuration of the system depends on N numbers, when we consider $\varepsilon_{ij} = \varepsilon = \text{const.}$, the energy of a given state depends only on two numbers : the long-range order parameter L and the short-range order parameter σ:

$$\frac{1}{N} E(L,\sigma) = -\frac{1}{2}\varepsilon\gamma(2\sigma - 2L + 1)$$

The parameters L and σ can be computed in the framework of various approximations of the initial (Ising) model. We suggest here the Bethe–Peierls (or "quasi-chemical") approximation.

Let us consider the n-dimensional periodic lattice mentioned in the subsection 2.2 and its corresponding energy:

$$E\{S_i\} = -\sum_{\{ij\}} E_{ij} S_i S_j \qquad (27)$$

where $S_i = \pm 1$, i = 1,…, N. We have already established that the sum have $\gamma N/2$. In a given configuration $\{S_i\}$ we call:

N_+ = the total number of spins "up";

N_- = the total number of spins "down".

Each pair of spins from the sum belong to on of the kinds: (++), (- -), (+ -), the last being no distinct from (- +). The corresponding number of pair will be N_{++}, N_{--}, N_{+-} . These numbers are not independent. The relations between them can be established as follows:

a) we link by lines a spin "up" with its nearest neighbours. Repeating for all the spin "up" we obtain γN_+ lines.

b) the number of double lines will be N_{++} and the number of simple lines, N_{+-} . Therefore

$\gamma N_+ = 2N_{++} + N_{+-}$

c) interchanging the indices "+" and"–"we have :

$\gamma N_- = 2N_{--} + N_{+-}$

The equations:

$$\begin{cases} \gamma N_+ = 2N_{++} + N_{+-} \\ \gamma N_- = 2N_{--} + N_{+-} \\ N_+ + N_- = N \end{cases} \qquad (28)$$

have the solutions:

$$\begin{cases} N_- = N - N_+ \\ N_{+-} = \gamma N_+ - 2N_{++} \\ N_{--} = (\gamma/2)N + N_{++} - \gamma N_+ \end{cases} \qquad (29)$$

so we can write:

$$\sum_{(ij)} S_i S_j = N_{++} + N_{--} - N_{+-} = 4N_{++} - 2\gamma N_+ + \frac{\gamma}{2} N \qquad (30)$$

Note that although the system configuration depends on N numbers, the energy of a given state depends only on two numbers: N_+ and N_{++} (We can consider $\varepsilon_{ij} = \varepsilon$ = constant). The number N_+ /N measures the "long range" order, while the number N_{++} / (γN/2) measures the "short range" order. The raison for this terminology is the following: having given a random distribution of spins and knowing that a certain spin is "up", the number $N_{++}/(\gamma N/2)$ is the fraction of nearest neighbours having the spin "up", thus involving a local correlation between spins: the other number, N_+/N, does not imply correlations between the nearest neighbors, but represents the fraction of spins from all the lattice having the orientation "up". We define the long-range order parameter L and the short-range order parameter σ through the relations:

$$\frac{N_+}{N} = \frac{1}{2}(L+1) \quad ; (-1 \le L \le 1) \qquad (31)$$

$$\frac{N_{++}}{(1/2\gamma N)} = \frac{1}{2}(\sigma + 1); \quad (-1 \le \sigma \le 1)$$

Replacing into Eq.(4), we get:

$$\sum_{\langle ij \rangle} S_i S_j = \frac{1}{2}\gamma N(2\sigma - 2L + 1) \qquad (32)$$

and the energy per spin, from Eq.(1), becomes:

$$\frac{1}{N} E(L,\sigma) = -\frac{1}{2}\varepsilon\gamma(2\sigma - 2L + 1) \qquad (33)$$

Now, let us call $P(s, n)$ the probability of n nearest neighbours to have the spin "up", if the central spin is "s". Thus, P(+1, n) refers to the configurations containing n pairs (++) and ($\gamma - n$) pairs (+ -); P(-1, n) refers to the configurations with n pairs (+ -) and ($\gamma - n$) pairs (- -). For n given, there are C_γ^n manners to choose the n spins from the γ nearest neighbors. We suppose that:

$$P(+1,n) = \frac{1}{q} C_\gamma^n \exp[\beta\varepsilon(2n - \gamma)] z^n \qquad (34)$$

$$P(-1.n) = \frac{1}{q} C_\gamma^n \exp[\beta\varepsilon(\gamma - 2n)] z^n \qquad (35)$$

where $\beta = 1/kT$ (k = Boltzmann`s constant; T= temperature), q is a normalization constant and z is a parameter characterizing the n spins sublattice. Imposing the normalization of the probability:

$$\sum_{n=0}^{\gamma}\left[P(+1,n)+P(-1,n)\right]=1 \tag{36}$$

we obtain :

$$q=\left[\exp(-\beta\varepsilon)+z\exp(\beta\varepsilon)\right]^{\gamma} + \left[\exp(\beta\varepsilon)+z\exp(-\beta\varepsilon)\right]^{\gamma} \tag{37}$$

Taking into account the signification of $P(+1, n)$ we get:

$$\frac{1+L}{2}=\frac{N_{+}}{N}=\sum_{n=0}^{\gamma}P(+1,n)= \tag{38}$$

$$=\frac{1}{q}\left[\exp(\beta\varepsilon)+z\exp(-\beta\varepsilon)\right]^{\gamma}$$

$$\frac{1+\sigma}{2}=\frac{N_{++}}{(1/2)\gamma N}=\frac{1}{\gamma}\sum_{n=0}^{\gamma}nP(+1,n)= \tag{39}$$

$$=\frac{z}{q}\exp(\beta\varepsilon)\left[\exp(-\beta\varepsilon)+z\exp(\beta\varepsilon)\right]^{\gamma-1}$$

The last equations express L and σ in the terms of the only variable z, which can be computed by solving (graphically) a transcendental equation. Then, Eqs. (12) and (13) give us L and σ and Eqs.(7) leads to the internal energy, E. The specific heat (the derivative of E), for $T > T_c$ is given by:

$$\frac{c}{kN}=\frac{2\gamma\varepsilon^2}{(kT)^2}\frac{\exp(2\varepsilon/kT)}{\left[1+\exp(2\varepsilon/kT)\right]^2} \tag{40}$$

We found that the specific heat (the derivative of E) exhibits a jump (Figure 3) at:

$$kT_C=\frac{2\varepsilon}{\log(\gamma/(\gamma-2))} \tag{41}$$

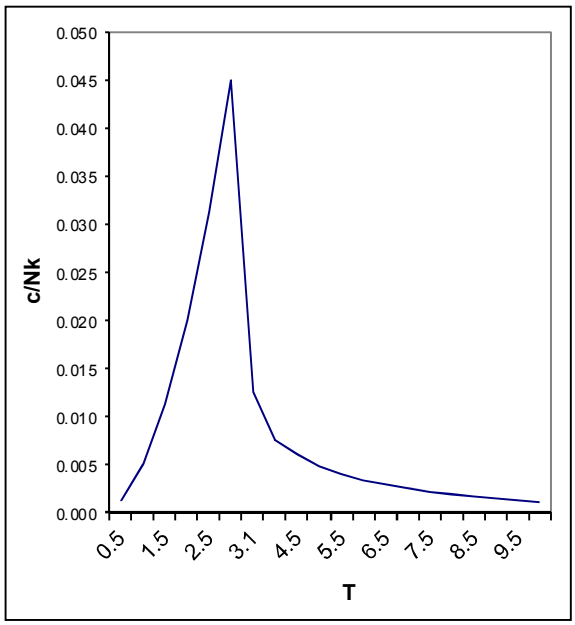


FIGURE 3. The specific heat of liquid ^{4}He as a function of temperature T at the pressure P = 0.227 MPa. The region of liquid states for ^{4}He is divided by $T_c \cong 2.2$K into two sub-regions: ordinary (viscous) helium or He I (on the right) and superfluid helium or He II (on the left) ([23])

FIGURE 4. New passenger car registrations in November in EU. Source: [24]

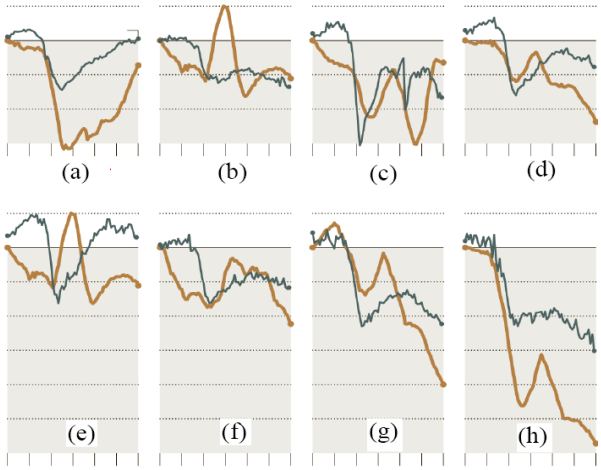


FIGURE 5. Change in industrial production and car sales: (a) US; (b) UK; (c) Japan; (d) Euro Zone; (e) Germany; (f) France; (g) Italy; (h) Spain. The United States reported a 2.2 percent rise in industrial production in 2012, pushing the rate past the 2006 average for the first time since the downturn began in late 2007. Production has also exceeded the 2006 level in Germany, although it began to slip in late 2012, but other major developed countries are still below that level. Car sales have recovered to some extent in the United States and Japan, but are still falling in much of Europe. Source: [25]

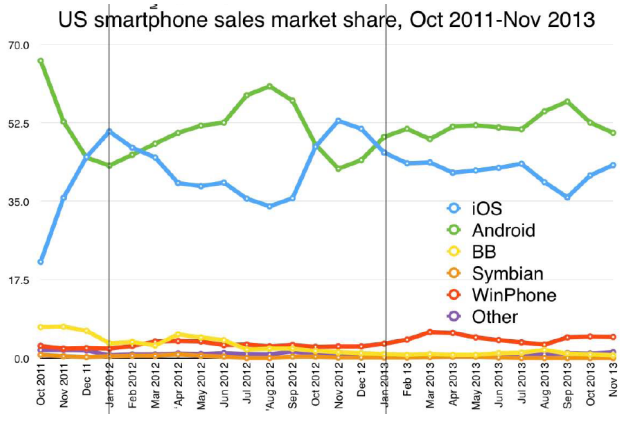


FIGURE 6. Market share for US smartphone sales. Source: [26]

There are some remarkable similarities between the shape of curves plotted in Figure 3 (the experimental result for a particular phase transition), and, on the other side, Figures 4-6 (the marketing data).

3.2 *Noise-Induced Transitions between Non-Equilibrium Steady States*

Physicists have noted, in several contexts, the possibility of a "critical state", in which independent microscopic

fluctuations can propagate so as to give rise to instability on a macroscopic scale. This a state in which chain reactions initiated by local disturbances neither damp out over a short distance (the "subcritical" case) nor propagate explosively, so that the system cannot remain in that state (the "supercritical" case). In this section we propose studying the role of the fluctuations in the neighbourhood of the critical points that seem to appear at the end of an economic cycle [27].

Let us consider, for the sake of simplicity, a single production process P, which produces a flux y of a certain commodity C. In the simplest form, the rate of increasing of the net product flux depends on the actual flux:

$$dy / dt = ky \qquad (42)$$

Eq. (42) allows for either an exponentially growing or decaying of the net product flux because it does not take into account some marginally effects such as *market saturation*: as more quantities of C enter the market, the offer increases so the price decreases, which in turn influences dy/dt. It is so more naturally to consider k as a function on y:

$$k = \beta - \gamma y$$

Here, the second term includes the competition effect and is similar to the "struggle for life" term in the Malthus-Verhulst model of population dynamics.

Substituting in (42) and re-scaling, we obtain the nonlinear differential equation (NLDE) of the process in the canonical form:

$$dq / dt = -q^2 + \zeta q \qquad (43)$$

According to the stability theory, for $\zeta < 0$, Eq. (43) has only one stationary solution $q^0 = 0$, which is stable. At $\zeta = 0$ a transcritical bifurcation appears (Figure 7): the solution $q^0 = 0$ becomes unstable and a new stable steady state branch arises, with $q^0 = \zeta$. The qualitative change suffered by the system when it goes through the bifurcation point is similar to a thermodynamic phase transition. According to the bifurcations theory terminology this is a "soft" transition.

The parameter ζ is supposed to be subject to fluctuations, being a Gaussian white noise with mean ζ_0 and variance σ. The stochastic differential equation (SDE) associated to Eq. (7.2) is:

$$dq = (-q^2 + \zeta q)dt + \sigma q dW \qquad (44)$$

or:

$$dq = f(q)dt + g(q)dW$$

where W is a stochastic Wiener process. (For simplicity we have dropped the index of ζ.).

In the same way as in the deterministic case, we compute the stationary solutions of the Eq. (44), i.e. the stationary points of the SDE, imposing:

$$f(q) = g(q) = 0.$$

One such point is $q = 0$ signifying that the ceasing of production (the collapse or the bankruptcy) is always possible for a system described by such equation.

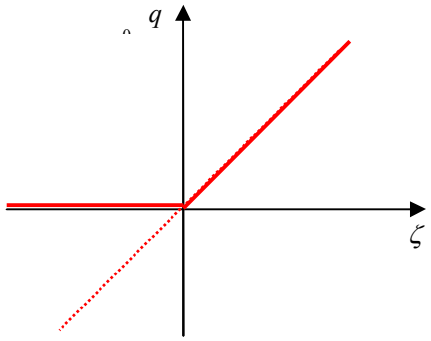


FIGURE 7. The transcritical bifurcation of the solutions in Eq. (43)

The question that naturally arises is whether, in addition to the stationary point $q = 0$, the SDE (44) has another stationary solution. The simplest way of solving this problem is analysing the Fokker-Planck equation (FPE) associated to SDE:

$$(\partial / \partial t)P(q,t) = -(\partial / \partial q)[(\zeta q - q^2)P(q,t)] + (\sigma^2 / 2)(\partial^2 / \partial q^2)[q^2 P(q,t)] \qquad (45)$$

The stationary solution of this equation has special interest:

$$(\partial / \partial t)P_{st}(q,t) = 0;$$

$$P_{st}(q,t) = P_{st}(q)$$

where $P_{st}(q)$ will be considered a probability density if and only if it is normalizable, i.e. its integral over the range $[0, \infty)$ is finite. The stationary solution of the FPE, having the form:

$$P_{st}(q) \sim q^{2\zeta/\sigma^2 - 2} \exp(-2q/\sigma^2)$$

is found to be integrable over $[0, \infty)$ only if $\zeta > \sigma^2/2$. With other words, the stationary probability distribution exists only if $\zeta > \sigma^2/2$.

After normalization we get:

$$P_{st}(q) = (2/\sigma^2)^{2\zeta/\sigma^2 - 1}\Gamma^{-1}(2\zeta/\sigma^2 - 1)q^{2\zeta/\sigma^2 - 2}\exp(-2q/\sigma^2) \qquad (46)$$

A remarkable aspect of the result is the drastic change in the character of the stationary distribution for $\zeta = \sigma^2$: if $\sigma^2/2 < \zeta < \sigma^2$, $P_{st}(q)$ is divergent for $q = 0$, while for $\zeta > \sigma^2$, $P_{st}(q = 0) = 0$.

Summarizing the previous sections and taking into account also the influence of the external noise, the following behaviours of the system are to be predicted:

a) For $\zeta < 0$, the stationary point $q^0 = 0$ is stable, making up the thermodynamic branch of evolution, on which the fluctuations are damped and do not lead to structural changes into the system. This feature can be extended for $0 < \zeta < \sigma^2$ (the domain of small fluctuations) where we have a new stable solution $q^0 = \zeta$ after the crossing through the transcritical bifurcation at $\zeta = 0$.

b) The critical value $\zeta = \sigma^2/2$ can be considered a threshold over that the stationary probability distribution $P_{st}(q)$ arises. For $\sigma^2/2 < \zeta < \sigma^2$, $P_{st}(q)$ is divergent for $q = 0$. Even if the solution $q = 0$ is no more stable, it remains the most probable. For $\zeta > \sigma^2$ a new change occurs in the aspect of $P_{st}(q)$, and the value $\zeta = \sigma^2$ becomes a transition point produced only by the external noise (In concordance with the usual classifications this is a "hard" transition).

We consider that second kind of transition is related to the shift of the economic system between two non-equilibrium steady states. As the phenomenon is induced by random fluctuations, the outcome is indeterminate; it is not unique and predictable. Nonetheless, it is reasonable the assumption that the distribution of transitions depends on the distribution of fluctuations. This relation could explain the empirical fluctuations reported in the marketing pages of various journals [24-26].

4. SOME CONCLUDING REMARKS

In this paper we analysed some interesting social phenomena such as fear/rumour effects and fashion fluctuations. These phenomena were intensively studied over the last few years using small-world network theory and simulations. Here we proposed an alternative way of modelling, using methods taken from statistical thermodynamics.

In the introductory section, we analysed some inherent difficulties related to the transfer of the conceps from physics to sociology. A subtitle of this section could be "What should we know before to reject the application of thermodynamics in social sciences?". Or to accept it – whichever you like.

In the second section, we considered the formation of the speculative bubbles in the stock market as an effect of rumours propagation. Using a phenomenological approach, we described the formation and the propagation of the patterns (or "dissipative structures") in the stock market, the spatial coordinate being the bid-offer spread y, as a function of which the spectrum ϕ of deals is modelled. The stock market was considered a distributed active medium that is a set of active elements (the brokers) interacting with others through deals (typically, a diffusion process). The physical model used is the reaction-diffusion model. The reactive part of the reaction-diffusion equation is developed from a hot-spot mechanism, with a characteristic jump when ϕ passes the critical value ϕ_c. Solving the stationary equation according to the Dirichlet boundary conditions, we found the "hot deals" regions, meaning regions of speculative transactions.

The nonlinear modelling touched in the third section offers strong tools to investigate both the individual and the global socio-economic complex systems. Nevertheless, it is worth to mention that this approach appears often as a "black box" which leads to a "convenient" set of outputs for a well-tuned set of inputs. The underground economic meanings of the control parameters and, in principal, the economic relevance of the non-linear equations fitting the empirical dataset, remain open questions for future studies.

5. REFERENCES

[1] Kulakowski, K., 2007, "Around the gap between sociophysics and sociology", paper prepared for the book *Lectures on Socio- and Econophysics* after the Summer School on Socio-Econo-Physics 2007 in Windberg http://xxx.lanl.gov/abs/0711.2880

[2] Arminger, G,; Clagg, C.C. and Sobel, M.E. (Eds), 1995, *Handbook of Statistical Modeling for the Social and Behavioral Sciences*, Plenum Press, New York.

[3] Parisi, G., 1988, *Statistical Field Theory*, Addison-Wesley, Reading, MA.

[4] Baxter, R.J., 1982, *Exactly Solved Models in Statistical Mechanics*, Academic Press, London 1982.

[5] Gligor, M. and Ignat, M., 2001, "Some demographic crashes seen as phase transitions". Physica A 301, 1-4, pp. 535-544

[6] Sznajd-Weron K. and Sznajd, J., 2005, "Who is left, who is right? ". Physica A 351, 2-4, pp. 593-604.

[7] Toral, R. and Tessone, C.J., 2007, "Finite Size Effects in the Dynamics of Opinion Formation". Communications in Computational Physics, 2, 2, pp. 177-195.

[8] Galam, S., 2003, "Modeling rumors: The No Plane Pentagon French hoax case". Physica A, 320, pp. 571–580.

[9] Zanette, D.H., 2002, "Dynamics of rumor propagation on small-world networks". Phys. Rev. E 65, 041908.

[10] Moreno, Y.; Nekovee, M.; Pacheco, A.F., 2004, "Dynamics of Rumor Spreading in Complex Networks". Phys. Rev. E 69, 066130.

[11] https://www.tradeking.com/investing/stock-investment-news

[12] Wio, H., 1994, *An Introduction to Stochastic Processes and Nonequilibrium Statistical Physics*, World Scient. Publish., Singapore, pp.175-204.

[13] Eliezer, D. and Kogan, I.I., 1998, "Scaling laws for the market microstructure of the interdealer broker markets", Oxford, preprint OUTP-98-64P. http://xxx.lanl.gov/abs/cond-mat/9808240

[14] Gligor, M. and Ignat, M., 2002, "Non-Equilibrium Patterns in the Space of the Stock Market Prices" Journal of Non-equilibrium Thermodynamics, 27, pp. 367-378.

[15] Galam, S. and Vignes, A., 2005, "Fashion, novelty and optimality: an application from Physics" Physica A, 351, 2-4, pp. 605–619.

[16] Aksu, M,; Pektaş, G.O.E. and Eseoglu, M., 2011, "Fashion Phenomenon in Postmodern Marketing Applications and Effects on the Marketing Components" Procedia Social and Behavioral Sciences, 24, pp. 325–339

[17] Blumer, H. G., 1968, "Fashion maddesi", International of Encyclopedia of the Social Science, USA, pp. 342-343.

[18] Davis, F., 1992, *Fashion, Culture and Identity*, Chicago&London: The University of Chicago Press, pp. 4-5.

[19] Breward, C., 2003, *Fashion*, Oxford University Press, pp.53-54.

[20] Crane, D. and Bovone, L., 2006, "Approaches to material culture: The sociology of fashion and clothing". Poetics 34, pp. 319-333

[21] Janssen, M. and Jager, W., 2001, "Fashions, habits and changing preferences: Simulation of psychological factors affecting market dynamics", Journal of Economic Psychology, 22, pp 745-772.

[22] Gligor, M. and Ignat, M., 2001, "Econophysics – a new field for statistical physics? " Interdisciplinary Science Review 26, 4, pp. 183-190.

[23] Arkharov, A; Marfenima, I. and Mikulin, Ye.,1981, *Theory and Design of Cryogenic Systems*, Mir Publisher, Moscow.

[24] Euronews, December, 14, 2012, http://www.euronews.com/2012/12/14/new-car-sales-plummet-to-record-lows/

[25] New York Times, January, 18, 2013, http://www.nytimes.com/interactive/2013/01/18/business/A-Slow-Recovery-Is-Better-Than-None.html

[26] The Guardian, January, 9, 2014, http://www.theguardian.com/technology/2014/jan/09/market-share-smartphones-iphone-android-windows

[27] Gligor, M., 2005, "Extremum criteria for non-equilibrium states of dissipative macroeconomic systems". In: *Variational and Extremum Principles in Macroscopic Systems* (Edited by Stanislaw Sieniutycz and Henrik Farkas), Elsevier, pp. 717-734.

MULTIDISCIPLINARY APPORACH TO INCREASING CREATIVITY: GAMIFICATION IN ORGANIZATIONAL CONTEXT

Diana Parlić [1], Mladen Čudanov [2], Gheorghe Săvoiu[3]

[1] Coca-Cola Hellenic, Batajnicki drum 14-16, Belgrade, Serbia, e-mail: diana.parlic@gmail.com
[2] University of Belgrade, Jove Ilica 154, Belgrade, Serbia, e-mail: mladenc@fon.rs
3 University of Pitesti, Str. Targul din Vale, nr.1, Arges, Romania, e-mail gsavoiu@yahoo.com

Abstract: *This paper presents the history of Gamification, some basic concepts and examples of implementation. Based on Werbach's approach, the description of gamification and some of its aspects are presented in relation to creativity, and the provision of Csikszentmihalyi's flow as a condition improving creativity in organization. In the conclusion, introduction of gamification skills and knowledge is seen as desired in the arsenal of the future managers, increasing multidisciplinarity of their theory and practice.*

Keywords*: Gamification, creativity, implementation, tools, concepts, history.*

1. INTRODUCTION

Gamification, as the use of game design elements in non-game contexts, [1] is in its essence a multidisciplinary approach, combining insights from game design, psychology, sociology, organizational sciences and depending on the context, numerous other disciplines. There are as many definitions, as there are authors, but no such definition is universally accepted. The one that is very often cited quotes that *Gamification* as an approach which uses game elements and techniques in contexts that have nothing similar to games themselves. [2]

The history of *Gamification* began in 1912, when the product "Cracker Jack" started producing a pack with a toy in his box. This approach has given a game character and a feeling to the product. Also, a long time ago, in 1964, the famous Mary Poppins used this approach in her song "A Spoonful of Sugar", trying to explain that "in every job that must be done, there is an element of fun" and when you find fun, your job will become a game.[3] Often neglected as unfit in a "serious" environment like business, gamification found its place in creative aspects of business research and practice, such as increasing creativity, and will probably find more applications in the future due to the social trends. According to research by AVG company new "Techno-toddlers" aged 2-5 know how to play a 'basic' computer game (58%), can make a call on a mobile phone (28%), or start a web browser (25%), but only 9% of them can tie their shoelaces [4].

On the other side, it is difficult to say what date we should consider as the start of using the term *Gamification*. However, there are resources that show us 2002 as a starting year, and Nick Pelling was the first who used this term for the purpose of explaining his workplace.[5] In the late 2000s, the term *Gamification* found its place in every day communication.[6] There was a lot of researche which aimed at determining the role that fun has in all of experiences that users will remember. Recently, many application designers started, instead of using game elements, directly to include video game elements. Typical examples were *Chore Wars* and *Bunchball*, appeared in 2007. *Chore Wars* is an application which included game elements to make housework easier and more fun. This application will present all family members as online characters and give them awards with every housework finished, and registered on the site *chorewars.com*.[7] Also, *Bunchball* was organized to give gamified business solutions to organizations and companies.[8]

A turning point in the popularization of the Gamification concept is the book of world famous game designer, Jane McGonigal, entitled "*Reality is Broken: Why Games Make Us Better and How They Can Change the World"*. Also, she is well known for her public speeches on game elements, and lectures as *The game that can give you 10 extra years of life.*[9] In 2011, the world's leading company in IT area, *Gartner,* added *Gamification* in its leading technology *"hype cycle"* [10], and Gabe Zichermann also made his contribution to *Gamification* development with his books and researches.[11] Around $25 million was invested in *Gamification* in 2011, and it was predicted that 50% of the organizations that want to innovate their processes will decide to include game elements until 2015. [12]

2. GAMIFICATION CONCEPT

Game elements have been applied in other contexts since prehistory and ancient times – the Olympic Games added playfulness, public awards and in general "games" to the concept of sport competition. The Happy Hours is also an approach which comes from history, and is used now for motivating people to participate or behave as predicted. The typical example is encouraging customers to buy cookies or rolls in the last working hours by decreasing prices. [13]

For the purpose of clear understanding of the *Gamification* concept, it is very important to be familiarized with the game itself and the game elements, as well as its characteristics and function. The main game elements are:

- The goal of the game – shows us what is expected from participants to achieve.
- Game area – is the area out of the real world in which participants will play a game.
- Game borders – are referred to any kind of limits, for example time limits, space limits, etc.
- Game rules – give an explanation of how participants will play a game.
- Objects – help us to keep up with the game in progress and results during the game. [14]

Kevin Werbach presents "The Pyramid of Elements" as a three-level framework for *Gamification* concept. Those levels represent three main categories of game elements, and they are [2]:

- **Dynamics** – are the structure which has a pattern and reflects experiences in games. The following are the main elements of dynamics:
  - Limits – are objects which exist in every game. Space limits, for example, in games make a possibility for participants to bring meaningful choices and solve interesting problems. It is considered that limits are one of the most important elements in games, so game designers should always think about it in details.
  - Emotions – as is well known, every game may cause different types of feeling – happiness, success, satisfaction, and also sadness or disappointment. Emotions encourage players to move forward, to participate in games, to spend time playing games, so this aspect is very important in every game.
  - Storyline – is the factor that makes a game whole, which collects all parts of game and compiles them in one. If the game does not have sense, *Gamification* will not be properly implemented and will not make the predicted results.
  - Progression – presents the player's cognition that s/he will be able to progress, respectively to change his/her current position. It is a concept that presents moving through levels or defined scale by collecting points or solving problems.
  - Relationships – are relationships between team players, but also between rivals or competitors.
- **Mechanics** – are defined as the processes or elements which encourage systems to move forward and players to keep participating in games.
  - Challenges – exist in games when the aim players should achieve is defined.
  - Chance – means that the result of a game is not always consequence of player's actions, but also includes accidental circumstances.
  - Competition and cooperation – elements that are opposite, but trying to encourage players to cooperate for achieving an aim, or fight for it against competitive players.
  - Feedback – gives information about current player's position and provides them with an opportunity to think and decide about their future steps.
  - Acquiring resources – is the process of achieving different kind of resources through the game, in order to encourage players to keep participating in games.
  - Awards – include any kind of benefits awarded through the game as recognition for achieving something, for moving through levels, etc.
  - Transactions – refers to every purchase or sale between players.
  - Turnovers.
  - Win definitions – define what is considered as a win in the game.
- **Components** – include typical examples of dynamics and mechanics, which are very often used in Gamification.
  - Achievements – are generally representative of quests which are included in games. They refer to achieving awards or moving through the game levels.
  - Avatar – is a virtual picture of every player in the game.
  - Badges – are graphic images of all achievements player had through game participation.
  - Boss fights – typically present finish game fights in the game, which is a fight on a high and difficult level or an obstacle.
  - Collection – refers to a collection of defined goods, resources, virtual stuff during the game.
  - Content unlocking – implies to previous set tasks or actions that players should complete to unlock next content or level.
  - Presents – have an impact to a time period which players spend in playing games. The way that games can make people have fun and be happy just because they are awarded something is very important.
  - Leaderboards – are typical element of every game and very often are used in *Gamification.* It is based on a status or a level which every player has on leaderboard, according to number of points or any other criteria.
  - Levels and points – levels are parts of game and all players are playing a game through these levels, but points are very often used as a way of awarding.
  - Challenges – which challenge players to participate in the game and move through levels and various actions.
  - Social influence – very important type of influence and means that players can follow what they friends do in games through social networking or participating in the same game.
  - Teams – are groups of players who participate in games together, as a team.
  - Virtual stuff or awards – refers to less important, small awards which players can take through the game. [2]

The SAPS Award System is based on four elements which represent awards and they all have influence status on the leaderboard. The elements are rated according to their influence on the players.

1. Status – is a position of one player compared to other players, and refers to a group of people or a team. This award can function in real world, but also in a virtual environment. The most commonly used mechanics which belong to status as element of SAPS are badges, levels and leaderboards.
2. Access – implies that defined group of players will have early access to particular activities or informations, as an award for levels passed or something similar. This type of awards is not in the money form, or another tangible form, but it gives a feeling of personal satisfaction to the players and high reputation among the other players.
3. Power – this element presents power as a type of award. The typical example for this type of award is assigning a role of forum moderator to the player who passed a defined number of levels or participated in some activities. Just because this player has a power of moderator's role will be enough for him/her to perform this role for free and to enjoy it. Many forums give similar types of power, a good example is the forum of popular video game *World of Warcraft*.
4. Stuff – given that the list of elements of SAPS reward system is composed by rank, we conclude that the last element on the list is one that players want least. This does not mean that it should be completely ignored, because there is always a group of players who want this award most. If you have a small reward that you can offer to your players, and that is exactly what they want, then this element of SAPS reward system is the one that will be the most effective. For example, there is no need to offer the player the status and the title of "King of ice cream," if what s/he wants is simply an ice cream. [15]

Authors Dan Hunter and Kevin Werbach propose 6D process for successful implementation of *Gamification* practice in organizations:

1. Define business goals
2. Describe target behaviors
3. Describe players
4. Define loop activities

5. Don't forget fun
6. Implementation of appropriate tools [16]

Many authors devoted their attention to fun as a feeling, and one of the segmentations conducted by Nicole Lazzaro, President and Founder of XeoDesign Inc., includes:

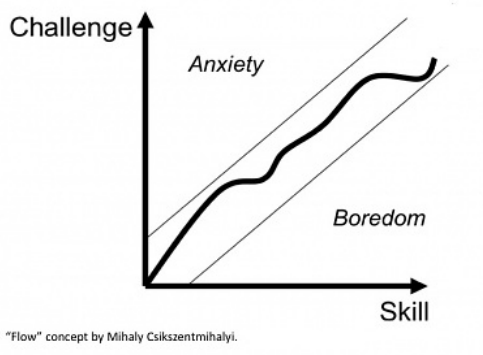
- "Easy" fun – hang out with friends and having fun which is everyday and commonplace.
- "Hard" fun – which includes some accomplishment, achievement, reaching a goal, recognition.
- Fun aimed at people – it is a kind of fun which can be realized through teamwork and in contact with other people.
- "Serious" fun – which involves creating a sense of fun while performing different activities that are in any way important to the person who performs them, regardless of whether the environment observes them the same. [17]

The issue that is important for many people who design *Gamification* practice is creating solutions that promote a sense of happiness in humans. Most often then not, this problem is viewed through positive psychology. The idea of positive psychology is actually based on the concept that generally takes psychology as a branch – unusual situations that arise and make people unable to think or to reflect in changed, different way than usual, bad situations with bad outcomes. Positive psychology, developed by Martin Seligman and Mihaly Csikszentmihalyi, is based on the research of what it is that makes people happy, which makes people feel successful and help them to prosper. Psychologist Jane McGonigal has defined the concept named *Perma*, the name being composed of the initial letters of the elements it consists of. These are:

1. ***P***ositive emotions
2. ***E***ngagement
3. ***R***ealtionships
4. ***M***eaning
5. ***A***chievement

McGonigal believes that these elements are the key for achieving a sense of happiness and fulfillment, a sense of self-satisfaction.[18]

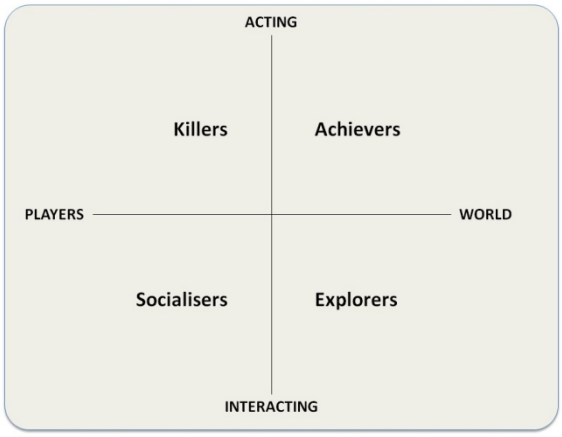
One of the creators of the theory of positive psychology, Mihaly Csikszentmihalyi, brought out some interesting findings related to the game and a sense of happiness that is created when people participate in games. He believes that games can cause two main extreme states: anxiety and boredom. The diagram explains where, depending on the dimensions, these states are.



"Flow" concept by Mihaly Csikszentmihalyi.

Csikszentmihalyi gives the following explanation for the diagram below. Those situations in which people participate in some very easy games, games that do not require specific skills, abilities and knowledge, produce a sense of boredom. The explanation says that the cause is that there are no ups and downs, there are no obstacles, no unsolvable step in the game, and people are not interested in playing. Another extreme situation is the one that includes a game which is too difficult. By too difficult games are meant the games that require skills, abilities and knowledge above average, games in which obstacles do not allow a player to progress. Such games cause anxiety and a feeling of dissatisfaction. Achieving a sense of happiness is somewhere between the two extreme states. The ideal situation is one in which the player never finds it too easy nor too difficult to play. Satisfaction is caused by a game which, as a rule, is sometimes heavier, sometimes easier, but which constantly records the jumps and crashes, and thus creates fun, which is the most important sense of games.[19] Such environment is found to be most beneficial for improving creativity in organization.

Understanding the players, their behaviour and characteristics, is an important process for the implementation of *Gamification*. The best known categorization is given by Richard Bartle [20], who presents four basic concepts of game participants. They are present in the graph, where the y-axis is located on one side and up to the other side of the world, and the x axis is defined with a specific behaviour, and the interaction with the other hand.



There are four basic types of players:

- Killers – their aim and satisfaction is not only to win, but they want to fight and feel as if they did something important for the whole world.
- Achievers – they see their success in an achievement or recognition of achievement, in something that will motivate them and lead to the goal.
- Socialisers – are the players who find most important contact with other players, and they enjoy interacting with them and encouraging communication.
- Explorers – as the name implies, they like to research. They want to explore the territory of the game, all the opportunities that exist in the game, always experiencing something new, and this is what leads them to the aim.

Despite this segmentation, it is important to emphasize that not all the players are distributed into categories. Most often it happens that a player combines characteristics of each type of player in the division above. It is often the case that a player is changing his/her behaviour during the time period.[21]

When we are talking about periods of awarding, we actually talk about the time when the award will be offered, and the frequency of rewarding. There are four options:

1. Continuous awards – this type of awards are rarely used in *Gamification,* because it means continually rewarding and here, the award is given automatically. Players are rewarded

too often and this, in fact, reduces the impact on people, their emotions and behaviour.

2. Fixed ratio – refers to giving a prize every n-th time when the defined activity happens.
3. Fixed interval – is very similar to the previous type of awarding. It implies an award that comes every n-th time units.
4. Variable awarding system – most often used in *Gamification*. No one knows the moment in which the prize can be given, and because it contains aspects of surprise, it is often used as a motivation. This type of rewarding is shown as a very powerful, considering players' response to them.[22]

3. SUCCESSFUL AND UNSUCCESSFUL EXAMPLES OF GAMIFICATION IMPLEMENTATION

The first example is related to language localization of *Microsoft* Windows 7, due to the fact that the company operates in a lot of different countries. The project is related to the use of elements of the game that refers to its internal application. For employees of Microsoft, this was an extensive, but not overly interesting job – to test a new operating system in the languages of those countries. In this situation, Microsoft had chosen the introduction of game elements, and in every country, in their own language, employees have tested Windows 7 and gave their own grade for the system. This encouraged all employees to perform better in their jobs and make a better "localized" Windows – the best in the company. Each localized operating system was viewed by all employees who gave their grades, and thus helped correcting mistakes and pointing out what is successful and good. Also, there was a table with the leaders, and all employees were able to monitor their results considering where their localized Windows is ranked on the list. This internal implementation of *Gamification* has produced the following results: 4,500 participants, more than 500,000 dialogue windows viewed, reported about 7,000 errors and made just as many repairs.[23]

Disney tried to introduce *Gamification* in their hotel complex Disneyland in California. This is an example of unsuccessfully implemented practice. The target group included all employees in a laundry in the hotel complex. In fact, in the room where the laundry was located, there was a huge monitor that was showing to all employees informations about their work performance. This means that each employee was able to see his/her results, but also the results of other employees. Those performance indicators informed employees about how quickly they fulfill their tasks, and the whole concept was based on the list of leaders, whose idea was to encourage employees to work more efficiently, better, with more effort. On the contrary, it was shown that this approach had the opposite effect than the one expected. Among the employees unnecessary competitiveness was generated, and such situations occurred where employees pushed with their results and their measurement, were skipping even their toilet breaks just in order to finish as much work as they could. On the other hand, those employees who were ranked poorly by the results in the list, were also under pressure because they constantly had the fear of losing their jobs.

Of course, employees' performance monitoring is the new generation concept, even very often carried out on jobs that involve routine work done. However, it seems that in this case Disney took the step of introducing a leaderboard too easy, not paying attention to how players, or their employees feel in this game, whether they want to participate, whether they enjoy the game and feel the fun or any other emotion that is desirable. Simply ranking employees, through a concept which is based on a leaderboard is not a solution that yields good results. Disney's example of unsuccessfully implemented *Gamification* is not the only one of this kind. Researches show that, among the elements that are commonly used in introducing *Gamification*, there is nearly always a list of leaders. In these situations, in most cases, it is not the list itself with leaders who produce opposite results than expected, but the feeling that is generated by the players during the game, referring to the fear before the fun.[2]

4. CONCLUSION

Employees' creativity is very desirable, while at the same time very hard for companies to achieve. Encouraged with creativity, motivated and satisfied, employees generate ideas that lead the organization towards achieving goals, maintaining their position in the market and survival in harsh conditions and numerous challenges of competition. Creativity helps the organization as a whole system, and in all areas of business. For this reason, it is important to know the methods and techniques to encourage employees and constantly strive for new organizational solutions that lead to the desired results. Mostly limited to psychology and organizational theory, the research of creativity in a business context did not include implementation of game design principles.

Gamification is a modern concept of organizational solution which involves employees in the game, leading them to the generation of ideas and innovations to create the basic products or services of the organization. However, for the implementation of these practices it is very important to know the basic concepts of gamification as a discipline. As it was shown in the examples provided, without understanding the basic concepts, gamification can work against the goals of the organization and its employees. A multidisciplinary approach which includes psychology, organizational theory and gamification needs to be followed if benefits of the gamification are expected for the organization. Sometimes motivation through the game may be in conflict with other motivators, so that creates a dilemma which of two motivators should the employee choose. Also, it is important for the organization to have the prerequisites for the implementation of Gamification, a well determined structure and to recognize significance of the introduction of this practice. Gamification opens vistas for a new discipline for modern managers, providing another skill in their multidisciplinary arsenal for the requirements of future business.

REFERENCES

[1] Deterding, S, Dixon, D, Khaled, R, & Nacke, L. From game design elements to gamefulness: defining gamification. (2011) In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, pp. 9-15, Tampere, Finland: ACM.Chicago

[2] Werbach K, Hunter D. – "For the Win", 2012, Wharton Digital Press, Philadelphia

[3] Fitz-Walter Z. – „A brief history of Gamification", 2013, online: http://zefcan.com/2013/01/a-brief-history-of-gamification/

[4] Norman, G. Children Know More about Computers than Riding a Bike (2011) available online: http://www.findmysoft.com/news/Children-Know-More-about-Computers-than-Riding-a-Bike/ [last accessed 30th May 2014]

[5] Pelling N. „The (short) prehistory of Gamification", 2011, online: http://nanodome.wordpress.com/2011/08/09/the-short-prehistory-of-gamification/
[6] Nick Pelling on Wikipedia, online: http://en.wikipedia.org/wiki/Nick_Pelling
[7] Chore Wars Game : Claim Experience Points for Housework, online: http://www.chorewars.com/
[8] Bunchball: The Leader in Gamification solutions, online: http://www.bunchball.com
[9] McGonigal J. – "The game that can give you 10 extra years of life", 2012, Ted Talks, online: http://www.ted.com/talks/jane_mcgonigal_the_game_that_can_give_you_10_extra_years_of_life.html?,
[10] Brockmeier J. – "Gartner Adds Big Data, Gamification, and Internet of Things to Its Hype Cycle", 2011, online: http://readwrite.com/2011/08/11/gartner-adds-big-data-gamifica#awesm=~om9HoQibY4TpBQ
[11] Gamification Corporation: The leading source for gamification news & info – About Gabe Zichermann, online: http://www.gamification.co/gabe-zichermann/
[12] Gamification: Learn about Gamification, History of Gamification, online: http://gamification21.wordpress.com/content/2-history-of-gamification/
[13] Aichholzer M. – Introducing Gamification, 2012, online: http://markenregisseur.at/wp-content/uploads/2012/08/gamification-factsheet_2012.pdf
[14] Gray D, Brown S, Macanufo J – "Gamestorming, A Playbook for Innovators, Rulebreakers and Changemakers", 2010, O'Reilly, Sebastopol, California
[15] Zichermann G, Cunningham C. – "Gamification by Design", 2011, O'Reilly, Sebastopol, California
[16] Werbach K. – Coursera lecture: "The Design Process", 2012, Gamification Course, online: https://class.coursera.org/gamification-2012-001/lecture/54
[17] Lazzaro N. – "Why we play games: Four keys to more emotions without story", online: http://www.xeodesign.com/xeodesign_whyweplaygames.pdf
[18] McGonigal J. – "Reality is Broken: Why Games Makes Us Better and How They Can Change the World", 2012, The Penguin Press
[19] Snyder C, Lopez S. – "Handbook of Positive Psychology", 2002, Oxford University Press, New York
[19] Self-Determination Theory: An Approach to Human Motivation & Personality, online: http://www.selfdeterminationtheory.org/theory
[20] Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. Journal of MUD research, 1(1), 19.
[21] Nicholson, S. – "A User-Centered Theoretical Framework for Meaningful Gamification", 2012, online: http://d-nb.info/1020022604/34#page=39, http://scottnicholson.com/pubs/meaningfulframework.pdf
[22] Finkel D, Wei Q. – „Gamers and the Games They Play", Worcester Polytechnic Institute, online: http://www.wpi.edu/Pubs/E-project/Available/E-project-050409-135413/unrestricted/MQP_Report_Final_Edited.pdf
[23] Smith, R. The future of work is play: Global shifts suggest rise in productivity games. In: Proceedings of the Games Innovation Conference (IGIC), 2011 IEEE International (pp. 40-43). IEEE.

THE NEED FOR A MULTIDISCIPLINARY APPROACH IN DEVELOPING AND IMPLEMENTING A GLOBAL STRATEGY

Milica Jovanović[1], Ivan Todorović[2], Stefan Komazec[3]

[1,2,3]*Faculty of Organizational Sciences, University of Belgrade, Belgrade, Serbia*
[1]*milica.jovanovic@ fon.bg.ac.rs ;* [2]*ivan.todorovic@fon.bg.ac.rs;* [3]*stefan.komazec@fon.bg.ac.rs*

Abstract. *This paper focuses on the importance of global strategy in contemporary business environment. The first chapter is introduction to the topics, and it explains the purpose of the paper and the main directions of the research. In the second chapter key aspects of globalization process are presented, the reasons why companies go global and the importance of multidisciplinary steps in the process of introducing a global strategy. Also, some basic multidisciplinary actions for developing global strategy are presented in this chapter, as well as the opportunities and challenges that global strategy copes with are highlighted. In the third section generic global strategies are presented from a theoretical point of view, and the fourth section contains the practical approach since the research began to be conducted for the Whirlpool Corporation. The concluding remarks and research implications are given in the final chapter.*

Keywords: *multidisciplinary approach, globalization, global market, opportunities, challenges, strategic management, adoption, aggregation, arbitrage, AAA strategies, generic strategy.*

1. INTRODUCTION

Considering any market as an isolated island is not in compliance with the characteristics of contemporary business, no matter what industry we are talking about. Globalization has become an unstoppable process, and it is spreading its influence on every aspect of everyday life (Kluyver, 2010). According to Interbrand website, we mostly use iPhones, wear Adidas sportswear and H&M clothes, use Windows OS on our computers, watch TV on Samsung devices, and drive Toyota cars (Best Global Brands in 2013, 2014). We are becoming global citizens who are living in a global economy. Borders are changed, or become loose, and language, distance and time barriers are vanishing.

The global competitive environment is constantly changing, and Boston Consultant Group recognized emergence of this process and called it "Globality" with the definition of "competing with everyone, from everywhere, for everything" (GLOBALITY: The Book, 2008). New markets, such as BRICS countries (Brazil, Russia, India, China and South Africa), are developing and opening up, which is shifting business activities on these areas. Emergence of these markets is giving corporations global opportunity to flow into new and still unsaturated markets. Although, in the past global business referred to companies from developed countries performing their business in emerging economies, nowadays, these boundaries no longer exist. There are no rules for global participants, and their roles and business performance and capital are going in both directions. This fact makes global market even more attractive for developed corporations, and it is a certain temptation which most of companies cannot reject. Most of them are going global and start being faced with the challenges of this global storm (Sirkin, Hemerling & Bhattacharya, 2008).

The process of globalization is challenging every contemporary firm by putting the dilemmatic question: to go global, or not? If the answer to the question is yes, an enterprise must take into consideration various factors, and examine which opportunities of globalization it could exploit, and which are the challenges it could face in that process. Global corporations are not instant products, they were not made immediately. This process has several gradual phases. It is starting with finding global sources, slowly entering on the international market, then becoming multinational, and in the end emerging into a global company (Luthans & Doh, 2009). This stages are, however, very difficult to accomplish and it takes a lot of effort, knowledge, proficiency and risk-taking to achieve every single one of them, and only "the chosen ones" can reach the final phase of becoming global. But, before going through all the above phases, the most important step is to precisely define the suitable strategy, and this component is directly responsible for the success of a company's globalization process. Such strategic management demands a multidisciplinary approach (Jemison, 1981).

In this paper, we describe the process of determining global strategy, the possible solutions and alternatives in choosing the right one, the general benefits and threats in process of developing and implementing the strategy and the importance of multidisciplinary approach in this process. Also, the Whirlpool Corporation is used as an illustration to present the global strategy implementation from a practical point of view. At the end, there are some conclusions with general remarks and implications.

2. ABOUT GLOBALIZATION

2.1. Why do companies go global?

The pressure of globalization, which most successful companies face, and switching the focus of business performance from local, or international, to a global level, have several important reasons. First, we have already mentioned that BRICS countries are newly emerged markets, and not only these areas, but some others (i.e. Asian markets) are also opening. These markets are very sensitive, and being the first entrant can give a company a competitive advantage among the rest of the competition. It gives the company time to position in the minds of consumers, which can provide long-term benefits for the firm as far as understanding the market is concerned, providing greater amounts of sales and learning about the domestic competitors. Then, increase sales and improved profit are also some of the main motivators for expanding globally.

By targeting larger markets, the approach to new customers is made easier and it is almost guaranteed that, if needs are determined carefully, the larger audience would be attracted by going global (Yip, 1991). Also, for companies that are doing business on small domestic markets, the main causes of

globalization could be achieving larger economies of scale, since they might sell products that are more widely accepted around the world. If we talk about financial security, successful global entrance could provide both short- and long-term security, and the financing of new products and projects development would be made possible, which provides increased innovation activities.

So, the benefits of globalizing a company are hardly questionable. But what is even more important than the decision of going on the global market is the process that follows after making that decision, and that is determining the ways of actions by which this process will be implemented. So, that "strategic guide" to globalization, which an organization must define, is the global strategy (Hamel & Prahalad, 1989).

At the beginning, it is important to distinguish whether this company is going internationally, multinationally or globally. When the objectives of the organization are focusing on the domestic market with some activities abroad we talk about a company that wants to become an international one; if the organization is going to develop a certain number of markets in which it performs its business activities, it develops multinationally, and if the organization wants to treat the world as a unique market, it goes globally (Ohmae, 2006). It is important to distinguish these categories because of the focus of the strategy that should be developed. International strategy focuses on the home market, multinational separately for each country and the global strategy must be developed by looking at all countries as a whole, which are representing a unique, global market.

2.2. Importance of global strategy

As we have said, a company sometimes searches for a larger audience than the domestic market. They seek for new sales and profits opportunities, whether the reasons are in poor wealth of domestic market, or because of fulfilling the demand on domestic market and going on the "next level" (Yip, 1991). Not only new sale are in the game, but also new resources that are offered in larger market. In those terms, we can distinguish four types of motives of going global (Main Types of FDI, 2011):

- Resource seeking – when companies are looking for natural resources or low cost labor force;
- Market seeking – the situation previously explained, when a company seeks for a market with unsatisfied demand, or when they are following their "big" customers that also go abroad;
- Efficiency seeking – when companies join with some partners, integrating in that way operations and establishing cross-border cooperation in specialization of products and processes, but not the whole business process;
- Strategic assets seeking – wider than the efficiency seeking, establishing long-term cooperation through acquisitions and alliances.

Global strategy should recognize which of the above are the motives for a process of globalization in a specific company and it will determine the future actions of developing strategy. If we look from the other perspective, globalization should lead towards lower prices of goods and services because of the larger amount of sales, and because of the cost reduction that should be achieved in this process. Also, if we go wider, global trade is becoming borderless, but still must be protected by law and other regulations that protect both countries and industries, so global strategy has an important role in the processes of negotiations.

According to Michael Porter (1986), a global strategy ought to provide the answers to several very important questions:

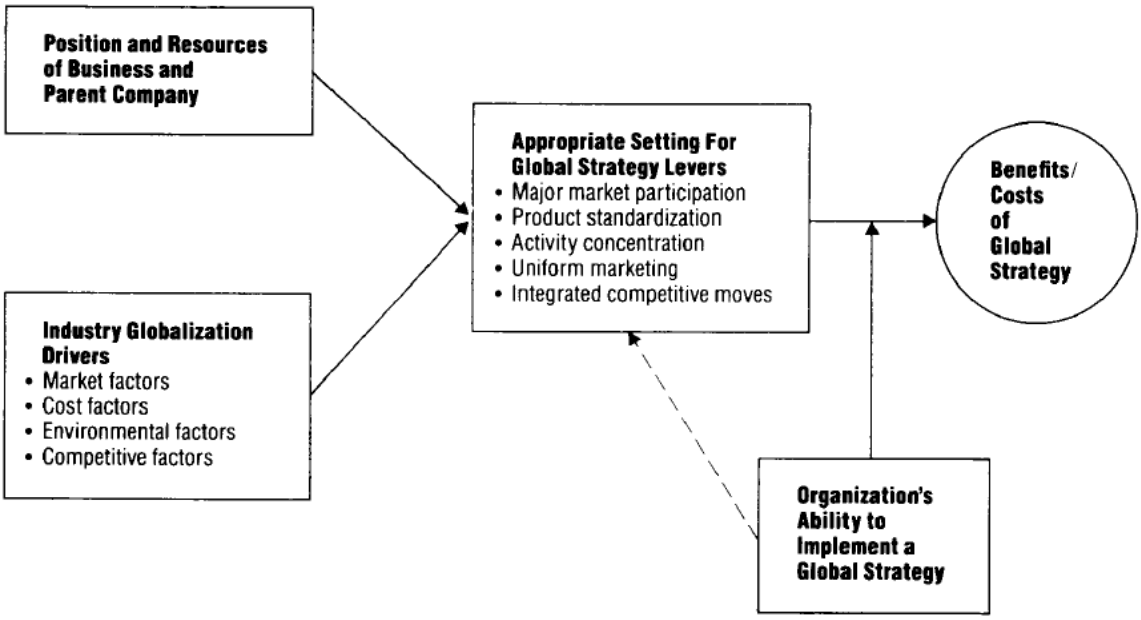
1) What must be the extent of market presence in the world's major markets?
2) How to build the necessary global presence?
3) What must be the optimal locations around the world for the various value chain activities?
4) How to turn a global presence into global competitive advantage?

Also, other research (Developing a global strategy, 2012) in going global come up with the conclusions that the strategy should:

1) Treat the global market as the domestic market
2) Create a global marketing mix, taking into account different tastes of customers and cultural and ethnical differences,
3) Concentrate on power brands, which are the most successful products, since the global market is very competitive and focus on narrowed scope of product would be easier to cope with, opposed to the wide range of different products.

2.3. A multidisciplinary approach to building a global strategy

Internalization is a strategic process (Melin, 1992). When developing a global strategy there are some multidisciplinary steps that every company must go through in going global. According to Yip (1989), developing the core strategy that is the basis of sustainable competitive advantage is the first one, and this strategy is firstly developed in the domestic market. Next step would be to internationalize the previously determined strategy through activities on international market and adaptation to new conditions of doing business. Finally, the last one would be to globalize the international strategy by implementing internationalized strategies across countries. The same author also defines conceptual framework of global strategy forces, focusing on the issues in the globalization process, and the framework shown in Figure 1.



Source: *Yip, 1989.*

Figure no. 1 Conceptual framework of global strategic forces

Kluyver (2010) also defines some stages of determining the global strategy through more concrete and multidisciplinary actions. According to him, the first stage of this process is market entry, where companies use business models that are similar to the ones in their domestic market. The second one is transferring the process of production to a market which has the lowest cost, and exporting the products to targeted markets, and in this step a company can start specialization in different products. In the next step, a company changes the structure of its supply-chain infrastructure and starts disaggregating the process of production and focusing each activity in the most suitable location concerning the availability of resources. The fourth stage involves further cost reduction by seeking lower labour costs and recomposing the business by searching markets with cheap work force. And the final, fifth stage would be to expand the market. So, in order to summarize all these steps, we have shown them in Figure 2. We have to stress that these steps are not strictly defined, and some of them can be skipped or combined with some other ones.

Source: *Kluyver, 2010.*

Figure no. 2 Five stages of going global

2.4. *Opportunities of global strategy*

Deciding to go global is a very risky move, but, which is unquestionable, if a process of globalizing is done in a proper way it brings numerous opportunities and benefits.

The economy of scope and the economy of scale influence cost reductions. Economies of scale reduce costs by sharing activities and transferring competencies from one group to another. On the other hand, the economy of scope reduces costs because of the higher volume of products which enables lower unit costs.

Considering lower costs, we also have lower labour and other resource costs, since, by globalizing, we can choose countries with cheaper work force and lower price of resources. What also causes decrease of costs are the better positions in negotiating with suppliers and other stakeholders because of the possibility of changing the environment of business performance (changing the countries). In that way, a company can dictate the terms of negotiations and provide better contract conditions.

A global strategy is also useful when it comes to extending the product life cycle. By performing on a global market, a company can introduce older products into newer markets and postpone the release of its products, while presenting the newest products on well-developed markets.

Apart from cost reduction, globalization provides global brand recognition, which imposes the necessity of improving the quality of products. Focusing on a narrow scope of products (which is a common strategy on the global market) helps

improving because of the higher specialization and better knowing it. This concentration enables taking the product to the next level.

Besides the benefits that are related to the company, there are benefits for customers also, since widely used products are globally available. For example, a customer from France that has an Apple iPhone maintained it in official service store in France, although it is produced in USA. Regarding customers we can also say that globalization is leading towards their better satisfaction, since nowadays they have standardized offers at various locations around the world. For example, every McDonald's customer knows what s/he can expect when s/he orders a Happy Meal.

Concerning the competitors, by globalizing a company gets better position for attacking the market and preventing "counterattacks" from its competitors. Another benefit of a global approach is the diversification of market risk, because a company can reduce its vulnerability to possible economic collapses or regional turbulences by extending geographically.

2.5. Challenges of global strategy

Even with such numerous benefits, explained in the previous section, globalization has certain challenges that have to be overcome in order to exploit the benefits that it offers.

Because of increased coordination, added stuff and reporting requirements, globalization may trigger increased management costs. Also, too much centralization may influence decrease of employee motivation in some countries, which would lead to a decline in their performance. Concerning operational risks, we also have higher transport and logistics costs. If the production process is outspreaded through several countries, then it will be necessary to transport the finished products from one country to another.

From the perspective of legal risks, a company must also consider each change of employment laws or corporation laws, to keep its activities legal. These challenges are also related to laws which protect a multinational's rights. Also, what a global company must pay attention to when entering new market are laws related to intellectual property, in order to avoid the risk of losing its technology or trademarks.

Financial-economic risks are related to the stability of a country's currency. The inconstancy of a country's macroeconomic performance and the country's inability to meet its financial obligations directly affect performance of a company doing business on its territory.

Exaggerated standardization of products may lead to unfulfilling the needs of customers, if the adaptation for the new market is not properly (or is not at all) done. It may also result in lower responsiveness and flexibility. Also, some markets have particular tastes or are more sensitive to pricing, so uniform marketing is something threatening not to discover these differences. So, a company must carefully estimate which product will be popular in each country, and also consider the price and the quality they are demanding.

Besides legal, market and economic challenges, there are also political challenges, related to the geopolitical stability of the environment in which a corporation is operating. Civil wars, economic meltdowns and strikes may have a devastating influence on business. So, in order to overcome these risks, a company must carefully examine the political environment and stability of a country, as well as its relationships with other countries.

At the end, there are also cultural and social risks related to globalizing business, which are just as important and real threats to global business as are political and economic risks. Understanding the local culture is a critical part of successfully running a business. Religious risks very often have an impact on everyday decisions, such as choosing the place for eating lunch or deciding which store we are going to shop in. Sometimes slogans in one language may mean something completely different in another language. In order to surpass these risks, local employees must assist in developing product lines and offers of the company.

3. GENERIC GLOBAL STRATEGIES

In the literature there are many strategies for globalizing a company. Here, we will focus on three generic strategies given by Pankaj Ghemawat (2007), since one of these strategies is related to the case study in chapter IV. Ghemawat defined three generic strategies for creating global value: adaptation, aggregation and arbitrage (known as AAA strategies), presented on Figure 3. The aim of these three strategies is to find the "right balance between economies of scale and responsiveness to local conditions". These three strategies can be implemented separately, but also their combinations of two were conducted in practice.

The **strategy of adaptation** considers changing some elements of the existing offer in order to satisfy requirements and needs of local customers. In this way, the revenues and market share are higher due to small changes towards local needs. Since almost every part on global market demands certain changes, this strategy is the most widely used strategy. We can find it in McDonald's for example, since a burger in India is not the same as the burger in Serbia. In India, because of the cultural specificity, there are no burgers made of beef. These are adjustments that McDonald's had to make in order to develop its business on the Indian market. Also, we have the example of adaptation in Ford Motor Company since their offer in US and European market is not the same, in Europe, their focus is on selling smaller cars (i.e. Ford Fiesta) in comparison to the American market where their main focus is on selling D-class cars such as SUVs. According to Ghamewat (2007), adaptation strategies can further be divided into five categories depending on a focus of a strategy:

- Variation – changes in products, services, adjusting to policies, business positioning and expectations for success;
- Focus – on particular products, geographies or market segments;
- Externalization – transferring strategies externally through strategic alliances, networking or franchising;
- Design – reducing costs by redesigning vs. variation of product;
- Innovation – improving the effectiveness of implemented adoption.

The **aggregation strategy** creates regional or global operations (when possible) in order to deliver economies of scale or scope as a way of dealing with differences. The main goal is to use similarities between regions in versus to adapting to differences but not executing complete process of standardization. The objective is to find a way to achieve economy of scale and scope, but not neglecting the needs of local market. Possible alternatives in developing aggregation strategy are to conduct geographic aggregation, cultural, administrative or economic aggregation, depending on the subject of globalization. For example, Windows 7 OS is not

translated into the Serbian language, because Microsoft assumes that the users are willing to use this operating system in their second language (cultural aggregation).

One of the best known cases of using the aggregation strategy is Wal-Mart, the American multinational retail corporation that runs chains of large discount department stores, in which front ends of the stores differ among countries, and the back end of the stores are always similar. In that way, most buyers outside USE do not even know they are purchasing in Wal-Mart stores.

The **arbitrage strategy** is the third and the final generic strategy. This strategy uses the differences of the markets, not adapting or going on economy of scale, but introducing a completely new original strategy. It this strategy, parts of the supply chain are often separated and located in different places (i.e. retail stores in USA, production facilities in Japan and materials from China). In nowadays business terms, we have outsourcing and offshoring.

Most suitable examples for this kind of strategy are IT companies such as Apple Inc. This corporation sells a wide range of technology products – mobile phones, tablets, portable media players, personal computers, etc. What is noticeable is that these products are mainly designed in the USA, and yet they are assembled in China. Also, the components of these products are originally from Japan, South Korea, Taiwan, and they are finally assembled in China. Outsourcing production in this way aims not only to decrease the costs of production, but also shortening the period of time of total production (Apple production, 2012). So, here we have economic arbitrage, where the focus is on decreasing costs of production or labor costs. Apart from this category, arbitrage can also be:

- Cultural arbitrage – related to country or place of origin;
- Administrative arbitrage – related to legal, institutional and political differences between geographic areas;
- Geographic arbitrage – surpassing borders and geographical distances.

In order to surpass these risks, local employees must assist in developing product lines and offers of the company.

Adaptation	Aggregation	Arbitrage
Variation Focus Externalization Design Innovation	Economy of scale Economy of scope	Economic arbitrage Cultural arbitrage Administrative arbitrage Geographic arbitrage

Source: *Kluyver, 2010.*
Figure no. 3 AAA Strategies

1. Whirlpool's global strategy: a case study

In this section we will present Whirlpool's implementation of global strategy from the perspective of previously defined AAA strategies.

Whirlpool manufactures appliances across all major categories, including fabric care, cooking, refrigeration, dishwashers, countertop appliances, garage organization and water filtration, which is present in almost every world country. Nowadays, Whirlpool is one of the world's top global appliance brands and markets some of the world's most recognized appliance brands, including Whirlpool, Maytag, KitchenAid, Jenn-Air, Amana, Bauknecht, Brastemp and Consul. In 2012, Whirlpool's revenue was $18.1 billion, and it had 68,000 employees all around the world (Whirpool Overview, 2013).

In the late 1980s the Whirlpool Corporation set the ambitious goal of becoming the leading producer of home appliances, and, as we can see, they have been successful in their mission. But how did they achieve that? At the moment of defining the goal, Whirlpool was positioned only on the US market. Mr. Dave Whitwam, CEO of Whirlpool at the time, recognized that the US market was surpassed, and that the company needed to expand abroad. The company made a series of acquisitions and the company had the scale and resources for going global. The idea was to establish relationships with millions of new customers in new, unexploited markets.

The areas that the corporation was focused on were Europe, Latin America, North America and Asia. In order to achieve its goals, by mid 1990s Whirlpool established solid position in Latin America and Europe, and was developing a marketing base in Asia. But then, in 1995 problems emerged and the numbers were declining. What happened?

In an article David Whitwam, CEO of Whirlpool Company, stated (The right way to go global: An Interview with Whirlpool CEO David Whitwam, 1994):

"Even though we had dramatically lowered costs and improved product quality, our profit margins in North America had been declining because everyone in the industry was ***pursuing the same course and the local market was mature****. The four main players – Whirlpool, General Electric, Maytag, and White Consolidated, which had been acquired by Electrolux – were beating one another up every day".*

So the problem was in saturated market and undiversified offer. In the same article, Mr. Whitwam said:

"We could have restructured the company financially and paid out a lot to our shareholders. We also looked at diversifying the business. If the major-appliances industry didn't offer growth, were there other industries that did? We looked at other kinds of durable products. We looked at horizontal expansion and vertical expansion. And in the process, it became clear to us that the basics of managing our business and its process and product technologies were the same in Europe, North America, Asia, and Latin America. We were already very good at what we did. What we needed was

to enter appliance markets ***in other parts of the world and learn how to satisfy different kinds of customers****."*

Initially, Whirlpool did not want to have the same strategy for all of the markets (Whirlpool Strategy, 2013). For example, in Europe they offered smaller washers and dryers than in the US, because market research showed that there are problems with organizing space in European homes. It also increased the entrance of its front-loading washing machines, which made pushing clothes into the machine much easier and contributed to increased sales. Companies also improved customer service and created appliances that were friendlier to the environment. In that way, if we now want to look from a theoretical point of view, they really did conduct adaptation strategy, from the variation category focusing on product dimension.

But what happened in other markets? By acquiring other companies, Whirlpool was able to offer more to its customers in increasingly competitive global market, by expanding its portfolio of products and services that were innovative and high-quality. After purchasing these companies, the challenge was to integrate them in order to create competitive advantage at the market. The company increased the speed of product development, making purchasing more efficient and cheaper. It refocused procurement, technology and product development by a global approach. But in markets such as Asia and South America, innovativeness simply was not enough.

By careful market research Whirlpool got the information that there is a large developing market for washing machines in China, India and Brazil. But "the catch" was that these markets were price-constrained since the customers had low purchasing power. Whirlpool hired engineers to develop washing machine that would be affordable to the customers on these developing countries. So, "*Ideale"* was created, a low-cost washing machine that was the key product which gave Whirlpool a secure position on these markets. And again, just from another perspective, we can see that Whirlpool applied an adaptation strategy, but this time they focused on the design category reducing the cost by redesigning a washing machine for emerging markets.

There is also a statement on their official website that confirms these conclusions (Whirlpool Innovation, 2013):

"At Whirlpool Corporation, we are extending our portfolio of leading brands across all markets and appliance categories, reaching consumers with new and exciting products in nearly every part of the world."

Whirlpool's global strategy is strategy of adaptation. They not only perform in new markets with existing products, but also improve existing products in order to satisfy the needs of local customers and adapt to the social economic conditions of the market. This is what happened when they came to Europe, when they expanded to Brazil, when they came to China and India. They adapted to the needs of the low-income consumer. They recognized the needs of the market, and were rewarded by increasing market share. Nowadays, they are large global company with one of the largest world market shares in the appliance industry, and their portfolio goes from global brands to regional and country-specific brands of appliances.

4. CONCLUSIONS

In contemporary market conditions it is not adequate to function on an isolated market. In addition, sometimes it is even not enough to exist on the open market; sometimes you must go further, looking the a new "place under the sun". The question is when to stop, when it is enough, when you are becoming greedy? In achieving certain level of development, companies face the question "whether to globalize or not". If deciding to go on the next level, it must be carefully performed, and the only way of directing it in the right way is by carefully defining a global strategy.

There are several reasons why companies go global. Some of them look for resources, some of them seek new markets, and some of them look for partners for both short- and long-term cooperation. Whatever the reasons, there are some multidisciplinary steps in defining the global strategy, and as Kluyver (2010) defined, they are: market entry, product specialization, value chain disaggregation, value chain reengineering and creation of new markets. Yip (1989) also proposes the framework for going global, which requires the multidisciplinary approach for completing all the phases.

But it is not easy to go global, although there are numerous opportunities that one could gain (cost reductions, extended product life-cycle, global brand recognition, improved quality of products, globally availability of products, standardized offer, diversification of market risk, better positions in negotiating, etc.), there are also many obstacles that it must overcome (increased management costs, decreased employee motivation, change of regulations, financial-economic risks, unsatisfied needs of customers, geopolitical stability, understanding the local culture). An extraordinary global strategy, original products, or a revolutionary technology can put companies on the competitive map, but only flawless execution can keep them there. In that process, only the strongest and the most capable can come out as the winners and get the "global" award.

According to Ghemawat (2007), there are three generic strategies that can be used in the process of globalization: adoption, aggregation and arbitrage. Depending on the company and the entering market, each of these strategies may be suitable to conduct, even the combination of two strategies if there is enough managerial knowledge.

In the example of Whirlpool we saw the utilization of two aspects of adoption strategy, from the perspective of variation on European markets, and from the design perspective in Brazil, China and India. We saw that acquisition of companies on target markets, efficiency, good products are not enough. They have to target key necessities of the market, explore, dig deep in order to discover its needs that will give them a comparative advantage on the market and/or industry. Only by carefully examining, predicting and defining precise global strategies for all the risks that can possibly emerge, can they be sure to overcome all the challenges they could cope with, and use the benefits and opportunities which globalization provides. Such activities simply demand a multidisciplinary approach in order to be executed.

REFERENCES

[1]. Apple production. (2012). *TUAW*. Retrieved June 2nd, 2014, from http://www.tuaw.com/2012/01/22/why-apples-products-are-designed-in-california-but-assembled/

[2]. Best Global Brands in 2013. (2014). *Interbrand*. Retrieved May 28th, 2014, from http://www.interbrand.com/en/best-global-brands/2013/top-100-list-view.aspx

[3]. Developing a global strategy. (2012). *Business Case Studies*. Retrieved May 30th, 2014, from http://businesscasestudies.co.uk/business-theory/strategy/developing-a-global-strategy.html#ixzz2sgXs6FbC

[4]. Ghemawat, P. (2007). *Redefining global strategy: Crossing borders in a world where differences still matter*. Boston , USA: Harvard Business School Press.
[5]. GLOBALITY: The Book. (2008). *BCG perspectives* . Retrieved June 1st, 2014, from https://www.bcgperspectives.com/content/articles/operations_globalization_globality_what_is_globality/
[6]. Hamel, G., & Prahalad, C. K. (1989). To revitalize corporate performance, we need a whole new model of strategy. *Harvard business review*, 63-76.
[7]. Jemison, D. B. (1981). The importance of an integrative approach to strategic management research. *Academy of Management Review*, *6*(4), 601-608.
[8]. Kluyver, C. A. (2010). *Fundamentals of global strategy a business model approach*. New York, USA: Business Expert Press.
[9]. Luthans, F., & Doh, J.P. (2009). International Management: Culture, Strategy and Behavior (7th edition). Boston, USA: McGraw-Hill/Irwin.
[10]. Main Types of FDI. (2011). *Investment Climate.* Retrieved May 30th, 2014, from https://www.wbginvestmentclimate.org/toolkits/investment-generation-toolkit/module1-step1-substep1_main-types-of-fdi.cfm
[11]. Melin, L. (1992). Internationalization as a strategy process. *Strategic Management Journal*, *13*(S2), 99-118.
[12]. Ohmae, K. (2006). Growing in a global garden. *Leadership Excellence, No. 23 Vol.* 9, pp. 14–15.
[13]. Porter, M. E. (1986). *Competition in global industries*. Boston , USA: Harvard Business School Press.
[14]. Sirkin, H. L., Hemerling, J. W., & Bhattacharya, A. K. (2008). *Globality: Competing with everyone from everywhere for everything*. New York, NY: Business Plus.
[15]. The right way to go global: An Interview with Whirlpool CEO David Whitwam. (1994). *Harvard Business Review*. Retrieved May 28th, 2014, from http://hbr.org/1994/03/the-right-way-to-go-global-an-interview-with-whirlpool-ceo-david-whitwam/ar/1
[16]. Whirlpool Innovation. (2013). *Whirlpool Corporation*. Retrieved June 2nd, 2014, from http://whirlpoolcorp.com/2012annual/innovation-improving.html
[17]. Whirlpool Overview. (2013). *Whirlpool Corporation*. Retrieved June 2nd, 2014, from http://www.whirlpoolcorp.com/about/overview.aspx
[18]. Whirlpool Strategy. (2013). *Whirlpool Corporation*. Retrieved June 2nd, 2014, from http://www.whirlpoolcorp.com/about/strategy.aspx
[19]. Yip, G. S. (1989). *Global strategy: In a world of nations?* Sloan Management Review, No. 31 Vol. 1, 29–41.
[20]. Yip, G. S. (1991). *Strategies in global industries: How U.S. businesses compete.* Journal of International Business Studies, No. 22 Vol. 4, 749–753

NOTE ON BEG'S PHYSICOCHEMICAL SOCIOLOGY

Libb Thims

Institute of Human Thermodynamics, Chicago, IL, USA, e-mail: libbthims@gmail.com

Abstract. An interjection on Indian-born Pakistani organometallic chemist Mirza Beg's 1974 'notes relating physicochemical terminologies to those of human behavior', in regards to humanities scholars unknowingly using physico-chemical terms, 'perhaps metaphorically', such as: polarization, activation, potential energy, complexes, compounds, etc., applied to human behaviour in lecture discourse, and resulting magnum opus *New Dimensions in Sociology: a Physico-Chemical Approach to Human Behaviour* (1987), is given.

Keywords: *Mirza Beg, physicochemical, sociology, physicochemical sociology*

1. INTRODUCTION

The relatively unknown physicochemical sociology theory work, developed and published between 1974 to 1987, of Indian-born Pakistani organometallic chemist Mirza Beg, on 'relating physico-chemical terminologies to those of human behavior', has recently been discovered (13 May 2014), by the author, which of the some 1,000+ biographies written at Hmolpedia, since its 24 Dec 2007 launching, is one of the more impressive finds, comparable in some ways to Goethe, and his 1809 affinity-based human chemical theory; though, to note, not as discerning as Goethe in regards to religion, which is in great conflict with the physicochemical purview of human existence.

The author finished reading and dissecting Beg's 224-page 1987 *New Dimensions in Sociology: a Physico-Chemical Approach to Human Behaviour* on 14 Jun 2014 during which time he has done 91 edits to Beg's *Hmolpedia* article, cited Beg in 35+ Hmolpedia articles, and presently ranks him as the #1 existive (alive) "social Newton", of the known 54 social Newtons (36 non-existive + 18 existive). [1] The author, after finishing Beg's book, then let it sit (digest) for 10 days, in the mean time reading Francis Crick's 1995 *Astonishing Hypothesis: the Scientific Search for the Soul*, which, to note, is nearly valueless, as compared to his 1966 *Of Molecules and Men*, wherein he debunks the "theory of life", with his seemingly innocuous passing remark "let us abandon the word alive", and herein will attempt a short summary "note" on Beg's work, which covers a large amount of theoretical ground, to say the least.

2. HIDDENNESS

In regards to why Beg's work is so impressive yet, paradoxically, so unknown, say as compared to other sociochemists, e.g. Thomas Huxley (1871), Vilfredo Pareto (1897), William Fairburn (1914), etc., or sociophysicists, e.g. Roy Henderson (1971), Elliott Montroll (1974), Serge Galam (1975), etc., of the same era or before, the issue seems to be firstly that Beg published his work in two obscure journals that in no way would be able recognize what he was saying, namely: *Pakistan Management Review* and *Pakistan Marketing Review*, having it reviewed seemingly by one scientist, namely M.A. Kazi, and one sociologist, namely Jameel Jalibi; and, secondly, that he threads all of his work, similar to Mehdi Bazargan (*Thermodynamics of Humans*, 1956), with all sorts of digression about passages and statements from the Quran and about the so-called life and times of Muhammad. While the advent of Academia.edu, wherein Beg recently (c.2014) began to upload abstracts and reviews of his 1987 physicochemical sociology book, thus allowing researchers to find his work, via the search keys "physico-chemical sociology", seems to have resolved the first of these issues, the second issue still remains, but is one inherent in any and all attempts of physicochemical formulations of the humanities, an issue that dates back at least to the time of Goethe and his so-called enemies deriding his work as immoral – which, naturally enough, leads into the question of what exactly is a "moral", something religion-based or physicochemical-based?

3. THEORY ORIGIN

In 1974, Beg, a chemist by training – his PhD was an organometallic chemistry dissertation on "The Chemistry of Some Trifluoremethylphosphines", completed in 1961 at the University of British Columbia, Vancouver – was nominated to attend a public administration training course, in which, as he says:

> "A peculiar feature of the course was that the lecturers were using terms, like polarization, activation, potential energy, complexes, compounds, perhaps metaphorically and in an unrelated context."

Beg, being curious about this unusually use of physico-chemical sounding language, being used in a course on public administration, queried the lectures: 'this compelled me to ask some of them if there were aware of the real sense of the terminologies which have actually been borrowed from chemistry or material sciences?' 'As expected', as he found, 'they had no clue to them and this prompted me to write a few notes, relating physicochemical terminologies to those of human behavior'.

This resulted in the 1976 booklet *Human Behavior in Scientific Terminology*, which led to the publication of four papers in local trade journals, two being 'Human Behaviour in Scientific Terminology Assimilation' (1980) and 'Human Behaviour in Scientific Terminology: Affinity, Free Energy Changes, Equilibria, and Human Behaviour' (1981) both published in the *Pakistan Management Review*. Reader response and commentary from these articles, according to Beg, made it become apparent that the 'pertinent data had to be put in urgently to provide a quantitative basis to the hypothesis'.

Beg's hypothesis, here, in short, being the proposal that human behaviour can be explained scientifically by the terms: affinity, free energy change, and equilibria, among about a dozen or so other physical chemistry theories that he examines.

In more detail, he likens society to a chemical solution and explains human behavior in terms of physicochemical laws, using terms such as fugacity, lattice energy, activation energy, affinity (or chemical affinity), free energy, drive (internal force and external force) and driving force, both interpreted in terms of Abraham Maslow's hierarch of needs, enthalpy (or heat of reaction), entropy, phase rule (phases, degrees of freedom, intensive variables, state), polarity, Coulomb forces, pressure (i.e. social pressure) and partial pressure (i.e. pressure at interface of social boundary), temperature (i.e. social temperature), equilibrium constants, etc., advanced concepts and principles, such as: Le Chatelier's principle, law of mass action (compare: Julius Davidson), human chemical reaction theory, activated complex, miscibility (compare: Jurgen Mimkes), etc., likening migration to evaporation of solution molecules at higher temperatures, social conflict to the generation of heat in solution, slums to the formation of coarse-grained solids, war to rapid boiling, etc., and seems to grasp at very-advanced concepts such as human chemical bonding theory (in a loose verbal sense) and human molecular orbital theory (e.g. via molecular orbital diagrams and transition states applied sociologically), all done with in-text citation to just four physical scientists: Willard Gibbs, Robert Boyle, Isaac Newton, and Robert Mayer, respectively.

Among these, Beg's use of fugacity, a complex concept developed by Gilbert Lewis, the main founder of modern chemical thermodynamics, is very original and quite impressive – something never before seen done by the author. In other words, while authors that cite, e.g., Heisenberg's uncertain principle, Newton's law of gravity, Clausius' entropy, or quantum mechanics, etc., in support of their new grand pet sociology, economics, philosophy, and or psychology theory, are a dime-a-dozen, the use of fugacity is very unique.

To continue, in 1987, following a period of forced convalescence, Beg was finally able to solidify his hypothesis, previously existing the form of a collection of terminology notes, four articles, and booklet, into his magnum opus *New Dimensions in Sociology: a Physico-Chemical Approach to Human Behaviour*.

4. DIGRESSION

While it will not be possible, at this juncture, to address all of the many points of Beg's hypothesis, herein we will take note of a few of the more impressive and interesting aspects of Beg's physic-chemical sociology theory.

Of first note, is the relative independence and originality of his work. In the physiochemical humanities, there tend to be two types of scholars: those that go straight from the textbook, physical science textbook that is, to theoretical humanities theory development, without citation or knowledge of any such similar scholar prior, and those that first cite and discuss thinkers to have attempted similar work prior to their own attempt. The latter far outnumber the former.

Beg is of the former time. A comparative example would be the rather impressive jump of American physicist and computer scientist Wayne Angel going straight from Herbert Callen's 1960 *Thermodynamics* textbook to an equation-rich theory he calls "relation thermodynamics", a thermodynamic formalism of human relationships and interactions. Beg does something similar, via further reading citation to about sixteen chemistry, physical chemistry, and material science books and textbooks, such as: *Physical Chemistry* (W.J. Moore, 1955), *General Chemistry* (J.A. Timm, 1950), *Introduction to Materials Science* (B.R. Shlenker, 1969), *Inorganic Chemistry* (T. Moeller, 1952), and *On the Nature of the Chemical Bond* (Linus Pauling, 1960), to name a few.

Throughout this jump, to be clear, Beg is completely unaware of the physicochemical humanities scholars to come before him, such as: Johann Goethe, Henry Adams, and Lawrence Henderson, to name a few. This is further evidenced by the following 2012 retrospect statement by Beg: [2]

"Writing to introduce *New Dimensions in Sociology through Physicochemical Approach to Human Behavior*, I had wondered as to why the degree of universality of occurrence and correlation of physical phenomena and physicochemical laws with social interactions has not been identified, although the identicalness of a large number of such natural phenomena is and has been well known."

In any event, one of the first interesting aspects of Beg's work is that he is the first, following Johann Goethe (1809), independently, Lawrence Henderson (1935), per extension of Vilfredo Pareto's grand corpus of work, and Jeremy Adler (1977), per dissertation work on Goethe's human chemical theory, to develop human chemical reaction theory, i.e. to define humans as fluid or chemical like points or molecules and to apply chemical equations, e.g. A + B → AB (product formation) or C + D ↔ CD (two way equilibrium reaction), to the modelling of human interactions, conceptualized as chemical reactions. [3] In all, Beg goes through about 26 types of human chemical reaction types, using chemical equations, even applying activated complex theory and transition state theory, along the way.

To cite one example, Beg, in chapter four "Human Interaction and the Socialization Process", begins to treat human molecules individually, e.g. how past psychological states (e.g. birth order or sibling group size), say of two potential friends, A and B, may affect later (adult) human chemical reactions processes (e.g friendship bonding), such as the formation of "close friends denoted by AB formed according to reaction 4.1", which Beg denotes as follows:

$$A + B \rightleftharpoons AB$$

or

$$A + B \leftrightarrow AB$$

Beg then goes on to calculate equilibrium constants (relative values) for the reaction scenario between three human molecular species: A, B, and C, and their possible products, e.g. AB, AC, BC, ABC, and secondary reaction mechanism products, which becomes rather involved.

5. FREE ENERGY

In his chapter seven "Decline of Societies and Entropy Changes", Beg states, as what seems to be a matter of fact, in

his mind, that Gibbs free energy change, defined by the following equation:

$$\Delta G = \Delta H - T\Delta S$$

is the equation for the driving force behind and underlying social change in and between societies and amid the rise and fall of civilizations (compare: Thomas Wallace, 2009).

6. QUOTES

The bulk of Beg's theory is in need of further digression and dissection. As this, however, will require an extensive amount of discussion, and as the author, presently, having just absorbed Beg's treatise 10-days ago, is oversaturated with the amount of theoretical ground that Beg covers, meaning his theory is in need of mental processing, we will forego further digression and discussion at this point, and leave the reader off with a few of the more interesting, of which they are many, quotes and statements by Beg:

"There are scores of evidences which suggest that human beings interact with one another because of the affinities they may or may not have for one another just like chemical substances."
— Mirza Beg (1987), "Preface" to *New Dimensions*

"The driving force of a reaction is another observation that could be related to the speed with which human interactions nucleate and either result in a revolution or in the domination of one faith over the other."
— Mirza Beg (1987), "Preface" to *New Dimensions*

"Physicochemical laws can be extended to a variety of human relations and interactions."
— Mirza Beg (1987), *New Dimensions in Sociology* (pg. 22)

"Mass migration can be viewed similar to boiling when the input of heat creates such intensive molecular motion that the molecules leave the system after changing to the vapor state."
— Mirza Beg (1987), *New Dimensions in Sociology* (pg. 35)

"Affinities and fugacities characterize the behavior of individuals in a society."
— Mirza Beg (1987), *New Dimensions in Sociology* (pg. 95)

"It is very difficult to have an ordered state in a heated atmosphere which results in separation of species."
— Mirza Beg (1987), *New Dimensions in Sociology* (pg. 135)

"Driving force of a [social] system is analogous to the energy which drives a chemical reaction to completion. It is, in chemistry, composed of two terms: the heat of reaction and entropy or disorderliness or randomness of the system."
— Mirza Beg (1999), *Social Pollution and Global Poor Governance*

REFERENCES

[1] (a) eoht.info/page/Mirza+Beg
(b) Beg, Mirza Arshad Ali. (1987). *New Dimensions in Sociology: a Physico-Chemical Approach to Human Behavior*. Karachi: The Hamdard Foundation.
(c) eoht.info/page/Social+Newton
[2] Beg, Mirza A.A. (2012). *Life Processes: Health, Aging, and Disease*. Pakistan: Research and Development Publications.
[3] eoht.info/page/Human+chemical+reaction+theory

COMMON POINTS BETWEEN CREDIT RISK AND PHYSICS MODELLING

Aretina David Pearson

Politehnica University of Bucharest,
e-mail: aretina_magdalena@yahoo.com

Abstract. *Monte Carlo methods are a standard way to model both physics and credit risk. A particular type of credit risk, the contagion risk, is further explained as a contagion risk operator acting on credit risk states.*

Keywords: *correlations, credit risk decomposition, systemic risk*

1. FINANCIAL DEFINITIONS

When lending cash/securities, one does lend a principal amount which will have to be completely returned, and will receive as well as additional cash or securities, usually named interest payments. "Credit risk refers to the risk that a borrower will default on any type of debt by failing to make payments which it is obligated to do. The risk is primarily that of the lender and includes lost principal and interest, disruption to cash flows, and increased collection costs. The loss may be complete or partial and can arise in a number of circumstances" [1].

The term *model* refers to a quantitative method, system, or approach that applies to statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates [2].

Except for credit risk, the other two most studied types of financial risk are the market and the liquidity risk. Market risk is defined as the risk faced due to changes in the market prices (ex: interest and exchange rates, stock and commodities prices). Liquidity risk is defined as the financial risk due to market liquidity (impossibility to sell the contract at the needed price) and due to funding liquidity (impossibility to get funded at the needed price). At present, there are two streams from credit risk, linking it to the market risk, via credit drivers, and to liquidity risk, via liquidity spreads, into an integrated market, credit and liquidity risk modelling.

The credit risk is usually measured by the CreditVar: the maximal loss faced due to credit risk events over a given time horizon and with a given probability. The faced loss is called exposure; it varies in time, and to get its present value one discounts its future value to the present time. Without entering into the details on what measure might be the best for the credit risk, we are going to focus on the causes and implications of particular type of credit risk: the contagion/systemic risk.

2. CREDIT RISK MODELLING

Up to a normalisation factor N, the credit risk CR_i , seen via the probability of default of counterparty i, is decomposed in a superposition of systematic risk, CRS_i, and idiosyncratic risk, CRI_i, at any moment t:

$$CR_i(t) = N * \left(CRS_i(t) \oplus CRI_i(t)\right)$$

The systematic risk CRS_i depends on the credit risk drivers whose values are independent on the financial health of the counterparty i. These drivers are generally chosen among market prices (as commodity prices, indices, interest and exchange rates), among macroeconomic factors (as unemployment rate, gross domestic product per capita, inflation rate), or even the original credit rating state.

The idiosyncratic risk CRI_i is completely determined and depends entirely on the counterparty i and its financial health. It is normally modelled as white noise, via a scaled Gaussian distribution.

The standard approach in the literature [3] of specialty is credit risk modelling via factors model, where the first term gives rise to the systematic risk, and the second term gives rise to the idiosyncratic risk:

$$Y_i = \sum_{k=1}^{K} \beta_{ik} * Z_k + \sigma_i * \varepsilon_i$$

The variable Y, called credit worthiness index, is mapped, via a Gaussian copula, into the probability of default of counterparty I and becomes random by the incorporation of the standard Gaussian distribution ε_i. While this might be a mathematically attractive model, little can be said about the systematic factors Z and how the factor loadings β can be calculated in practice.

One can have a different description of the defaulting event if we look at it from the point of view of the hazard rate H_i. The probability of default at time t, $Q_i(t)$ is written as a function of the probability of survival, $S_i(t)$:

$$Q_i(t) = 1 - S_i(t)$$

Where:

$$S_i(t) = \exp\left(-\int_0^t H_i(\tau) \cdot d\tau\right) \qquad \text{(Eq. I)}$$

If we consider the exposure on the interval $(0,t]$, with respect to the counterparty i to be the sum between the number v of contracts of value V:

$$E_i(t) = \sum_{j=1}^{J} v_i^j * V_j(t)$$

We could write the credit risk at moment t as:

$$CR_i(t) = E_i * \left(1 - CRS_i(t) * CRI_i(t)\right) \quad \text{(Eq. II)}$$

The systematic risk is the risk due to credit risk drivers:

$$CRS_i(t) = \exp\left(-\int_0^t \left(\sum_{k=1}^{K} a_G^k * X_k(\tau) \right) d\tau \right)$$

It is in practice hedged by derivatives or/and by netting agreements.
The idiosyncratic risk is meant to represent the diversification in the portfolio of counterparties:

$$CRI_i(t) = \exp\left(-\int_0^t (a_G^0 + \varepsilon_i) \cdot d\tau \right)$$

This represents the specific risk, completely related to the credited institution. A risk that is specific to a firm or industry can be theoretically canceled by diversification and it is called unsystematic or idiosyncratic risk.

In the equations above, X_k represent the K risk drivers to which counterparty i might be sensitive to, while the a^k are the regression factors when regressing the hazard rate H_i on the distributions of the risk drivers. The parameter a^0 represents the fact that counterparties from the group G, on which the regression is done, have a larger or smaller random, specific risk.

Once the regression factors are inferred from the existing data, knowing the forecasted behaviour of the risk drivers $X(t)$, the value and magnitude of the future probability of default and future credit risk can be Monte Carlo simulated and predicted.

3. SUBTYPES OF CREDIT RISK: SYSTEMIC / CONCENTRATION RISK

Systemic Risk is Contagion Risk. Systemic risk is generally used in reference to an event that can trigger a collapse in a certain industry or economy. It is related to the best studied type of credit risk: counterparty credit risk.

Even if liquidity risk is not considered to be a type of credit risk, there is a non-negligible correlation between liquidity and credit risk, because liquidity risk is mostly affected by and affects the systemic credit risk and the concentration risks. Here we will look at ways to understand the impact and formation of systemic risk. It is important to note that systemic risk is not due to individual institutions per se, but rather to the interconnections between the institutions. Systemic risk refers to the risks imposed by interlinkages and interdependencies in a system or market, where the failure of a single entity or cluster of entities can cause a cascading failure, which could potentially bankrupt or bring down the entire system or market [4, 5].

Systemic risks can arrise from market risk, credit risk dependency, funding concentration, exposures concentration and large specific/idyosynctratic risk.

In finance, systemic risk has been associated with a financial institution run which has a cascading effect on other financial institutions to which the first institutions owns money, causing a cascading failure. As depositors sense the ripple effects of default and liquidity concerns cascade through money markets, a panic can spread through a market, with a sudden flight to quality, creating many sellers but few buyers for the now illiquid assets. These interlinkages of the financial institutions runs are the issues which policy makers consider when addressing the issue of protecting a system against systemic risk.

The credit events experienced by the counterparties are the default and the changing in rating states. Because decreases in the rating state can be seen as a price variation and included in the market risk, we can simplify and limit the analysis of the systemic risk of the crediting financial institution at the risk strictly coming from the defaults of its counterparties. Unforeseen default can only take place when the idiosyncratic risks of different counterparties become correlated [6].

4. SYSTEMIC RISK EXEMPLIFIED

3.1 Interaction due to credit risk drivers

Mathematically, starting from Eq.II, concentration risk (correlated losses of counterparty i_1 and counterparty i_2) may show up whenever counterparties i_1 and i_2 are exposed to the same credit risk drivers X.

This leads to a systemic risk. And there is a causal dependency between any of the counterparties. If A is correlated to A' due to their common dependency on a given variable, say X=HMI (House Market Index). If the house market reaches a critical soil, both A and A' will default. But this is concentration risk and it takes into account when default is caused by common risk factors. When there is a non-causal correlation, even if A defaults, A' will not be affected.

The fact that counterparty A depends on counterparty B, who depends on counterparty C, who depends on counterparty A is called wrong way risk. It is the risk we are facing when having as counterparty one member of the cluster ABC (say lending the money to A) and hedge it by a deal opened with another member of the cluster (say gives as collateral a bond on C). In [7], one models the dependence relation between the default time of the counterparty and those of the underlying names in a reference portfolio and shows that there is an enormous joint impact of correlation and contagion due to the wrong way risk. We are not dealing hereby with wrong way risk, which is not systemic risk, even if it leads to it.

The only possibility that the systemic risk appears, in the absence of wrong way risk and concentration risk, is that all the idiosyncratic risks get affected at the same time.

3.2 Systemic Risk is Contagion Risk

Equally defined as the risk that financial difficulties at one or more banks spill over to a large number of other banks or the financial system as a whole, the risk of contagion is a different perception of systemic risk. Contagion Risk

represents the financial institution's perspective of the risk for the bank to be affected by a systemic effect. Managing it firstly means identifying the factors that, affected by the contagion, will lead to the bank's losses due to contamination.

Sometimes merely called market risk, systematic risk is the risk inherent in the aggregate market that cannot be solved by diversification. Systematic risk refers to overall market risk.
The idiosyncratic risk due to the counterparty *i* is given by:

$$CRI_i(t) = \left[\exp(-a_G^0) * \exp(-\varepsilon_i)\right]^t$$

When the financial institutions FI_1 and FI_2 share the same counterparties:

$$CR(FI_1) = CR_1 = \sum_{i=1}^{I} CR_i(t)$$

$$= \sum_{i=1}^{I} E_i - \sum_{i=1}^{I} E_i * \exp(-a_G^0 t) * \left[\exp(-\varepsilon_i t)\right]$$

$$= C_1 - \sum_{i=1}^{I} C_2(a_{G1}^0; t) * \exp(-\varepsilon_i t)$$

$$= C_1^{1'} - \sum_{i=1}^{I} C_2^1(a_{G1}^0; t) * Y(\varepsilon_i; t)$$

$$CR(FI_2) = CR_2 = C_1^2 - \sum_{i=1}^{I} C_2^2(a_{G2}^0; t) * Y(\varepsilon_i; t)$$

In an ultraglobalised environment, the systemic risk arrises because the idyosincratic risk, given by the alleatory variable ε, stops being alleatory, as the financial institutions share the very same alleatory variables. Because this common idiosyncratic risk is due to diversification itself, via globalisation, it cannot be canceled by further diversification and has to be seen as a Systematic Risk, representing the contagion/systemic risk.

The survival probability with respect to a borrower/counterparty, as expressed in Eq.I can be rewritten as:

$S=H*X^T$

H could be interpreted as an operator on the state $X=(X_S, X_I)$, representing the financial institution in the frame of credit risk drivers. Here we have *K+1* sources of uncertainty: X_S is a vector of size *K*, X_I is a vector of size 1. Starting from the decomposition of H on the different credit drivers, one can fit their loading factors.

A first application of this decomposition is that, based on predicted values for the credit drivers, Monte Carlo simmulations can be employed in order to deduce the future values of credit risk faced by financial institutions.

As a second application, the idiosyncratic risks of two financial institutions can get correlated in absence of any common market risk factor when *the financial institutions have a lot of clients/counterparties in common*. Systemic risk is produced by globalisation as everybody is exposed to the whole world and to all the industries. Systemic risk is caused by and increases with increased idyosincratic risk. Because "Supervisors were not aware of the systemic implications of institutional funding and liquidity management, and how idiosyncratic risk (e.g., sub-prime credit risk) could quickly morph into a systematic liquidity risk for the financial system as a whole." [8]

5. CONCLUSIONS

REFERENCES

[1] *The International Financial Reporting Standards Database and Textbook*, Board of Governors of the Federal Reserve Ssystem (2011).

[2]*Guidance on Model Risk Management*, Basel Committee on Banking Supervision (2003).

[3] Dan Rosen and David Saunders, *Risk Factor Contributions in Portfolio Credit Risk Models,* Journal of Banking & Finance, Volume 34, Issue 2, February 2010

[4] George G. Kaufman (World Bank), *Banking and currency crises and systemic risk,* Internet Archive

[5] *Containing Systemic Risk*, CRMPG III (2008)

[6] Leung, S.Y. and Kwok, Y.K., "Credit default swap valuation with counterparty risk", The Kyoto Economic Review 74, 25-45, 2005

[7] *Contagion models a la carte: which one to choose?* Harry Zheng, Imperial College.

[8] International Monetary Fund, "Global Financial Stability Report", October 2010, Chapter 2: *Systemic liquidity risk: Improving the Resilience of Financial Institutions and Markets*