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AN ECONOPHYSICS MODEL FOR INVESTMENTS AND ECONOMIC DEVELOPMENT

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Abstract. *Most of the econometric and econophysics models have been borrowed from the statistical physics, and as a consequence, a new interdisciplinary science called econophysics has emerged. In this paper we planned to extend the analogy between different economic processes or phenomena and processes/phenomen from different fields of physics, other than statistical physics. On the basis of the economic development process and amplification phenomenon analogy, a new econophysics model, named "economic amplifier", on the electronic amplification principle from applied physics was proposed and largely analyzed.*

Keywords: *econophysics models, electronic amplifier, β economic amplification coefficient.*

1. Introduction

Economic phenomena, processes and complex structures analyses imply theories and models borrowed from some other sciences, especially from exact sciences (mathematics) or/and nature sciences (physics) where laws and phenomena have an exact character, a determinist one. Such approches guiding to interdisciplinary directions of studies and analyse allowing quantitative determinations and forecasting for economic sciences, are met in econometry and econophysics.

As known, the economic forecast projective models, for modelling of various economic activities etc., are widely and successfully applied in economic theory and practice. The confirmation of the validity of these widely used models is of paramount importance and great theoretical and practical interest. If this confirmation comes from the exact sciences and from the natural laws' sciences (physics and chemistry) has endorsed a high accuracy, due to the use of the exact sciences, being checked by the

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physical laws in accordance with the laws of nature. And this is the great importance of econophysics for economic theory and practice.

If the physics or econophysics models confirm various economic models, established by economic science or practice (the Keynes, Domar, Cobb-Douglas models etc.), then they get the endorsement of accuracy and that of well founded theoretical laws or equations existing not only as semi-empirical equations but as well defined **economic laws**.

Physics, is the most suitable for modeling the economic phenomena and structures or financial-banking operations, because it takes into consideration the process variables characteristics and permits to use some procedures – including the mathematical one – especially probability theory for minimizing or eliminating such influences depending on human factor.

During last decade, on the basis of many studies and published papers and books, a new interdisciplinary science has appeared named econophysics, which uses models taken especially from statistical physics to describe some economic phenomena and processes.

Most econophysics approaches, models and papers that have been written so far refer to the economic processes including systems with a large number of elements (such as financial or banking markets, stock markets, incomes, production or product's sales, individual incomes etc.) where statistical physics methods, and Boltzmann, Gibbs and some other statistical distribution types are mainly applied [1÷16].

Reducing econophysics only to of statistical physics applications in economy, especially in the stock-markets analysis, seems to be very restrictive. It is desirable to investigate other fields of physics, and economy too, in which processes similarity inspire and even facilitate to adopt new econophysics models using – where it is possible – some other physics fields too.

This paper proposes an extension of analogy between different economic phenomena and processes and phenomena or processes from different fields of physics, other than statistical physics, especially from electronic physics and condensed matter (solid state) physics.

2. Economic growth and development represents an amplification phenomenon

Any economic activity, regardless of its objective, must be effective, that means besides the fact that it should not have losses, it is necessary to

obtain benefits i.e. profit or an increase in initial investment. In other words, growth or economic development is an amplification phenomenon similar to the phenomenon of amplification of physics and engineering which is produced by devices as transistors or amplification integrated circuits. So the economic growth means the amplification of the value of utilised and processed resources. In this way, taking in consideration the importance of economic development model and production amplification, in this paper a model based on amplification concept from electronic physics, named **economic amplifier** was proposed and discussed. The model implies an electronic amplifier realized with active electronic devices, the most by used being the device named transistor, which represents itself an excellent amplifier, of both current and electrical power [17,18].

The transistor and the electronic amplifier made of transistors, present the features of an exact model, a determinist one. Thus, if the transistor is used for economic modeling, it guarantees the same accuracy and validity to the economic models to which the electronic amplifier model is correlated and assimilated.

This is the reason why in the next section the principles of the electronic amplifier will be briefly presented.

3. Electronic Amplifier

Any electronic amplifier has an active element which is either bipolar transistor (with *p-n* junctions) or field effect transistor (MOS type).

In this section we are going to present some parameters and characteristics of bipolar transistor with *p-n* junctions and the MOSFET structure and characteristics.

3.1. The bipolar transistors

As it can see in figure 1,a, the bipolar transistor is made of two semiconductor *p-n* junctions, first junction (emitter junction) being forward biased with positive V_{BE} voltage, and the second one (collector junction) being reverse biased with V_{CB} voltage, with:

$$|V_{CB}| \gg |V_{BE}|. \tag{1}$$

By proper biasing of the junctions, the transistor will be crossed by emitter, base and collector currents (I_E, I_B and I_C) which are in the following [17,18]:

$$I_E = I_B + I_C \tag{2}$$

in which I_E represent the current due to injection of charge carriers from emitter region to base region where they are transferred into collector circuit as collector current I_C under the action of electric field of collector junction (Fig. 1,a).

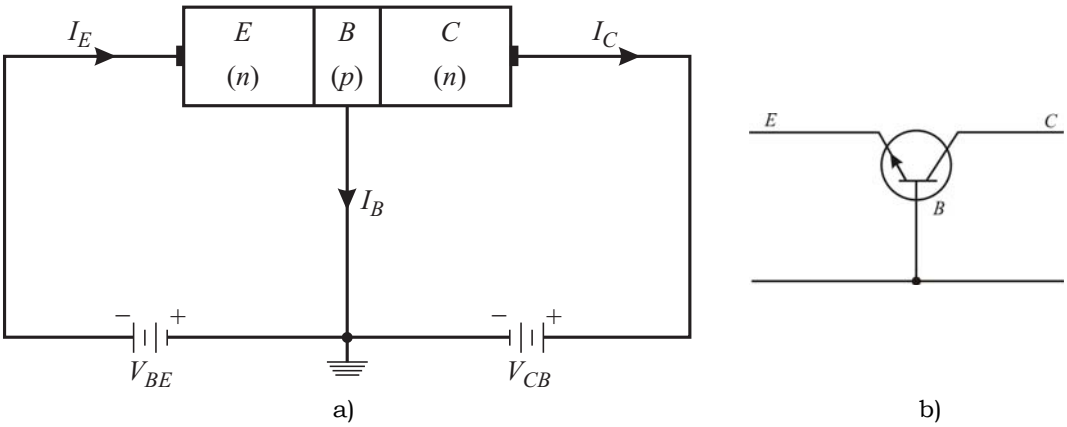
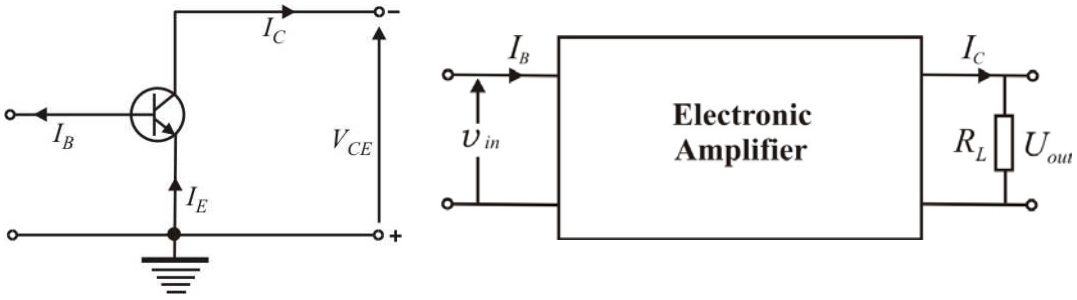


Figure 1. a) The structure and bias for the *n-p-n* bipolar transistor; b) the symbol for the *n-p-n* bipolar transistor.

Due to inverse currents of minority carriers from collector and emitter regions and recombination current of charge carriers in the base region, the base current I_B is much smaller than I_E or I_C:

$$I_B << I_C \tag{3}$$
$$I_C \approx I_E.$$

Considering the transistor as a quadruple (Fig. 2,b) there are three ways to connect it in circuit, one of electrodes being common to both input and output circuits: CB configuration (with common base), CE configuration (with common emitter) and common collector configuration (CC) [17,18]. In amplification circuits the common emitter configuration is mostly used because it provides a highest power amplification (gain) (Fig. 2,a and Fig. 5).



a) b)

Figure 2. a) The *n-p-n* transistor common emither (CE) configuration;
b) Simplified representation of an electronic amplifier.

A simplified representation of the electronic amplifier with the bipolar transistor in common emitter configuration is given in figure 2,b.

The current amplification coefficient for transistor in CE configuration represent the ratio between output current I_{out}, that is collector current I_C, and input current I_{in} that is I_B :

$$\beta = \frac{I_{out}}{I_{in}} = \frac{I_C}{I_B}. \tag{4}$$

Replacing I_B from equation 2 in relation 4 we obtain:

$$\beta = \frac{I_C}{I_B} = \frac{I_C}{I_E - I_C} \gg 1. \tag{5}$$

because $I_C \lesssim I_E$. From (5) it can be noticed that the bipolar transistor in CE configuration is a very good current amplifier because amplification coefficient β is much grater than 1 (usually β = 100 ÷1000 or more).

Generally, the transistor, like any other amplifier, is used to amplify variable signals, v_{in}, all these being much smaller then biasing voltages:

$$| v_{in} | \ll V_{BE} . \tag{6}$$

In this case we have the dynamic regime of transistor functioning to small signals, when voltages and/or variable currents can be considered as little variations of the biasing currents or voltages [18]:

$$v_{in} = V_{BE} = \Delta V_{BE}; \quad i_C = \Delta I_C \quad \text{etc.}$$

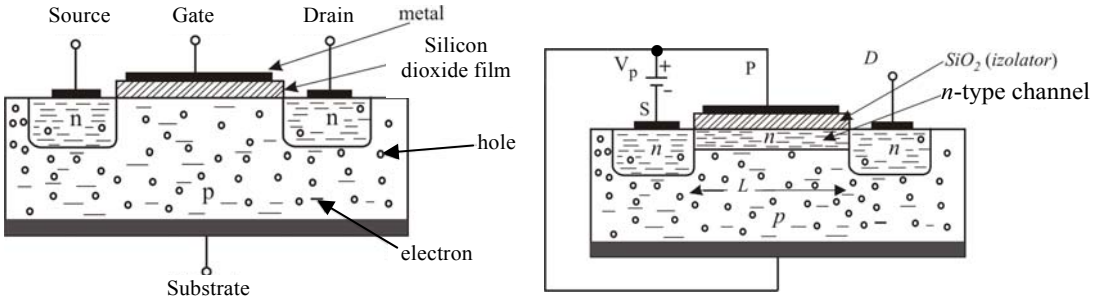
In dynamic regime for variable voltage and currents small letters are used for noticing magnitudes, meaning i_b, v_{in}, i_c, v_o etc.

3.2. Unipolar Metal-Oxide-Semiconductor (MOS) transistors

The unipolar transistors also contain two *p*-*n* junctions but they are functioning with only **one** charge carriers type, the majority ones (where their name came from) on the basis of field effect, being named Field Effect Transistors (FET) also [17,18].

There are several types of these transistors but the most often used in current applications is Metal-Oxide-Semiconductor (MOS) transistor where control electrode named Gate is isolated from the device through an oxide or dielectric thin film (Fig. 3,a).

The analog of emitter from bipolar transistor is the Source (S) where charge carriers are coming from, and the analog of collector is the Drain (D) that is collecting the carriers (Fig. 3,a,b).



a) b)

Figure 3. a) FET structure of *n* channel-MOS type;
b) The conduction channel induced in the MOSFET structure.

Initially, the source and drain regions are completely isolated so there is no current flowing in the MOS structure from figure 3,a, between source and drain. If a positive voltage is applied between gate and source there will appear a conduction channel of *n*-type between source and drain where the electrons there the majority carriers will be able to flow (Fig. 3,b).

The channel that has been formed is one that has been induced due to gate positive potential action that will reject the holes from the region placed exactly under oxide to semiconductor depth of *p*-type substrate. The positive gate voltage will attract the mobile electrons from the *p*-substrate in this region which being in large number under oxide will create a *n*-region that represents the conduction channel between source and drain (Fig. 3,b).

After channel creation between drain and source, if a positive voltage $V_{DS} > 0$ is applied, the electrons injected into the source (by biase voltage) will flow to drain through channel, and therefore, a drain current I_D will result (Fig. 4). By varying input voltage V_{GS} (which includes a variable voltage v_{in} that must by amplified), the thickness and electrical resistance of induced *n*-channel will vary (Fig. 4) and, as a consequence, the drain current I_D will vary, too. In this way, an amplified output voltage U_{out} can be taken from load resistor R_L :

$$U_{out} = I_D R_L. \tag{8}$$

From figure 4 it can be seen that as result of applying voltage $V_{DS} > 0$, the *n*-conduction channel is narrowing to collector region limiting I_D current reaching the saturation value $I_{D\,sat}$ [17,18].

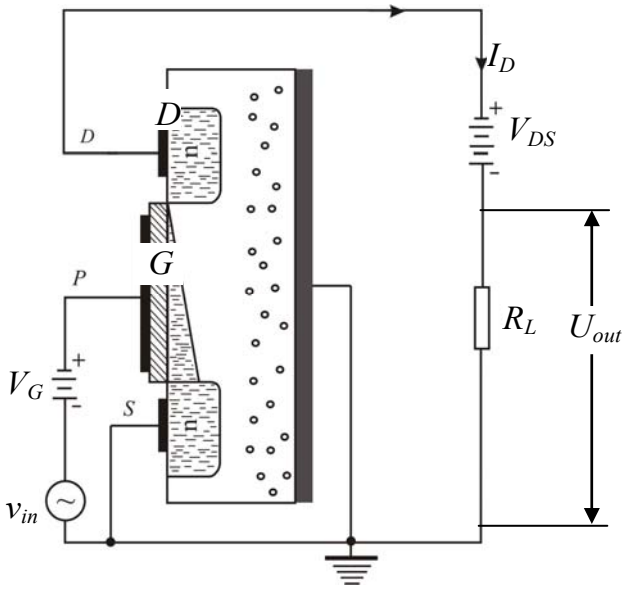


Figure 4. MOSFET in the amplification regime ($I_D \neq 0$).

For the MOS transistor the slope *S* or transconductance g_m is defined as [18]:

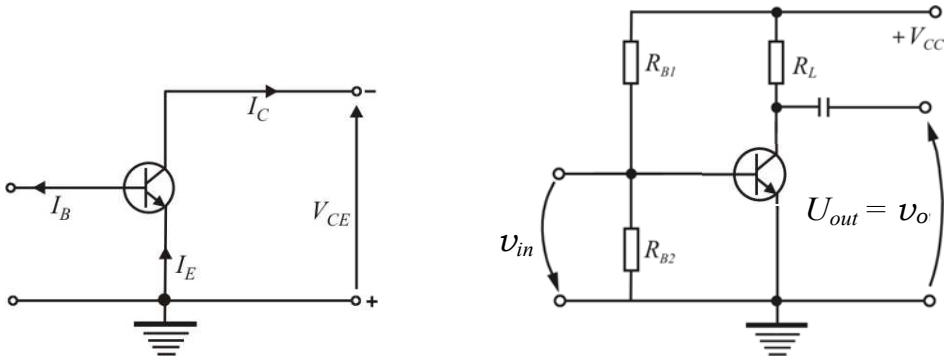
$$g_m = S = \frac{\partial I_D}{\partial V_P}. \tag{9}$$

PMOSFET (*p*-MOS Field Effect Transistor) with *p*-type induced channel is functioning in the same way where source and drain regions of *p*-type are diffused in a substrate of *n*-type and bias voltages are opposite to

those of NMOSFET, so $V_{PS} < 0$ and $V_{DS} < 0$. In both cases, MOS transistors are functioning with only one type of charge carriers: electrons or holes, so they are unipolar transistors.

3.3. Electronic amplifier with bipolar transistors

Figure 5,b represents a practical circuit of an amplifier with bipolar transistor in common emitter (CE) configuration (Fig. 5,a and Fig. 2,a). To avoid using a supplementary source for V_{BE} voltage, a voltage divider R_{B_1}, R_{B_2} for proper biasing of base (input circuit) in used. The amplifier has only one amplification stage because it uses only one transistor (active element) for amplification. To increase the amplification, the amplifiers with two or more transistors, having two or more amplification stages are used [17].



a) b)

Figure 5. a) The *n-p-n* transistor common emitter (CE) configuration; b) amplifier circuit with a bipolar transistor in CE configuration.

If a small variable signal υ_{in} is applied to amplifier input (Fig. 5,b) an amplified signal is taken from load resistor R_L as output voltage (see also Fig. 2,b):

$$\upsilon_o = i_c R_L = U_{out}. \tag{10}$$

The current amplification coefficient is given by Eq. (4) that is practically the same with current amplification coefficient for the variable signals:

$$\beta = \frac{i_c}{i_b}. \tag{11}$$

Also, an amplified power is put out on the load resistor R_L (Fig. 2,b):

$$P_{out} = U_{out}\, i_c = i_c R_L i_c = R_L i_c^2 \tag{12}$$

these obtaining a power gain of the signal applied to amplifier input.

4. Economic Amplifier

In this paper a model based on transistor-effect from physics, meaning **amplification phenomenon** that can be realized using transistors, was proposed. Such a model can be used for modeling different economic structures or processes such as production or investment fields, steady capital, founds or financial – banking fields, stocks etc.

Transistor-effect of amplification of transistor device is completely verified in practical activities. Modeling physical phenomena on the electronic level for bipolar and unipolar transistors theory is validated through all technological and socio-economical developments of nowadays society, this little device being the base brick of all electronic apparatus and equipments in any field of activity. The same overwhelming confirmation of transistor model validity (which is multiplied in hundreds and thousand millions of components into microprocessors or some other integrated systems) gives to the transistor the leader status of all contemporary discoveris and practical applications in physics and techniques. That's why the transistor deserves the whole attention of researchers that are studying models of different human activity phenomena and processes, especially economics, finances, management etc. The almost universal validity of amplification phenomenon, in particular by transistor-effect, guarantees the validity of economic model action on the basis of electronic amplifier with transistors, that we named "economic amplifier model".

First example of similitude and modeling with transistor model is represented by assimilation of charge carriers in transistors with the number of products realized inside a production section or a factory etc. by an economic unit.

As charge carriers current flows through transistor from input to output (Fig. 1), the products flow from input (where they represent parts, raw materials etc.) to the output of a section production or a manufacture and then all this stuff is delivered as finite products.

The role of load resistor R_L from output circuit (Fig. 2,b) is taken by storage or transportation (conveyors, containers, trains etc.) systems which

deliver products to consumers in the same way in which charge carriers are collected from load resistor as current intensity I_C.

The expression $I_C R_L$ represents the output voltage being assimilated with technical platform – production ensemble from workshop, manufacture or factory etc. where equipments, labour force (human factor) and other production expenses are included.

The **charges** carried by charge carriers are assimilated with **values** that final products are carrying that represent "valor carriers".

The economic amplifier can be interpreted as an Input-Output model like one stage transistor electronic amplifier. So, economic amplifier model can be analyzed using Eq. (8) for current amplification coefficient, β, of bipolar transistor:

$$\beta = \frac{I_{out}}{I_{in}}. \tag{4'}$$

In this way if we consider that at the input circuit, between base and emitter a signal assimilated with investments (capital or in nature) introduced into factory (economic unit) is applied and at the output as current I_{out} we consider the total amount of products or total income obtained, we can define so called β_{economic} coefficient. This coefficient can be defined for all quantity of products β_p as:

$$\beta_{p\ \text{economic}} = \frac{\text{Total quantity of finite products}}{\text{Investments, raw materials and equipments}}. \tag{13}$$

A more important parameter can be introduced being the ratio of the value efficiency determined by the total amount of incomes (business value) shared over the investment amount, marked by β_v:

$$\beta_{v\ \text{economic}} = \frac{\text{Total Incomes}}{\text{Investments} + \text{Expences}}. \tag{14}$$

The unipolar transistors of MOS type are most suitable econophysics model for describing banks and other financial institutions operating with **only one** economic category: money, because the unipolar transistors operate with only one type of charge carriers [17,18]. Here, similar to bipolar transistor, we work with financial investments as money on the input allowing to obtain a big total output income after a period of time (a year, a month etc.) so, a biger than unity gain is obtained. The growth (amplification) of the invested capital under the action of interests, commissions etc. is equivalent to the amplification concept from applied

physics (electronics). Otherwise, the **gain** obtained from banks, stocks etc. is similar to the **gain** obtained from transistor amplifiers where we have a gain for bank (equivalent with the gain for current, β given by Eq. (4)):

$$\beta_{bank} = \frac{\text{Values (money, interests etc.) obtained at the output}}{\text{Total Values (initial capital + Amount obtained + Given Interests) at the input}}. \quad (15)$$

Obviously, the amplification factor β_{bank} is calculated for a period of standard time (for example: a year, a month, a week etc.) that is, over the time, of the financial operations execution.

The bankruptcy of an economic agent (company, banks etc.) is modeling by the transistor breakdown or circuit failure. Circuit damage analysis could inspire solutions for bankruptcy avoidance. Transistor burning (bipolar or unipolar) could come from exploitation errors (improper voltages), supercharges, design errors, or because of semiconductors material quality, that is, for the reasons associated to the improper structure and design of the material, device (transistor) or circuit (amplifier). Similar these types of errors are also met because the managerial drawbacks, lower staff qualification, lack of communication, improper average age for a specific production stage of the company etc.

The modeling using more transistors and more amplifying stages can be used for the bigger economic systems such as big factories or corporations etc. So, one stage amplifier (using one transistor) is modeling one section activity. The multi-stage amplifiers having a big gain can simulate a factory with many sections. The bigger amplifier with many stages including the output power one are used to model a corporation or a big trust having a very large gain (amplification coefficient) and manufacturing a large amount of products [17].

5. Economic development modeling using the economic amplifier model

The economic amplifier model can be very well applied for modeling the economic development based on the initial investments both at the micro and the macroeconomic levels [19]. So, for the bipolar transistor (CE configuration), the output current I_C (mA) as a function of input current, I_B (μA), therefore, β, given by Eq. (4), has a linear dependence, resulting a constant value for β (Fig. 6).

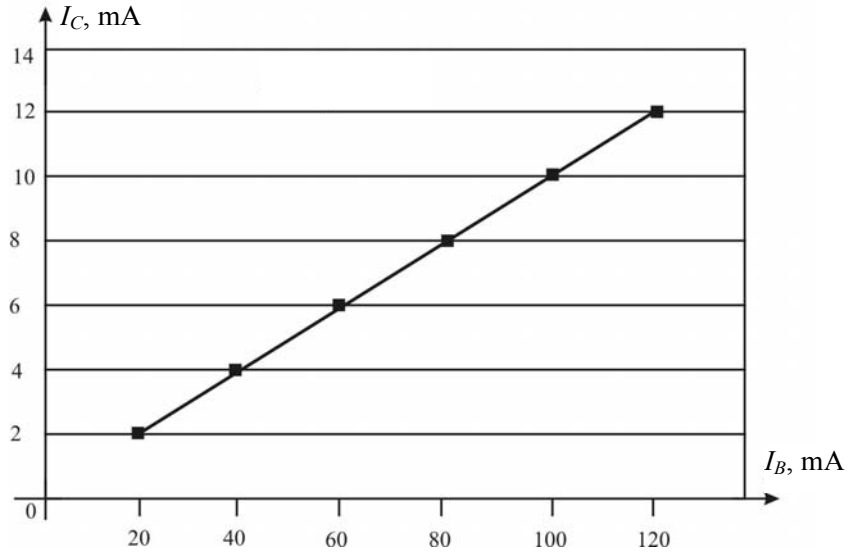


Figure 6. $I_C = f(I_B)$ dependence represents a straight line.

Indeed, the Eq. (4) can be written as:

$$I_C = \beta I_B \tag{16}$$

representing a straight line (when β = const) intersecting the origin of the axes. If it is not the case and the intersection with vertical axis is a_0, Eq. (16) is becaming:

$$I_C = a_0 + \beta I_B \tag{17}$$

also representing a straight line.

The Eq. (16) is a simple regression one, exactly as the equation obtained for the one-variable ("one-factorial") econometric model [19,20] for which a_0, and β are the regression coefficients. Therefore the economic amplifier model is a true econometric model and implicitly an econophysics one.

Under normal conditions and economic policies by applying the economic amplifier model for the investments, one may see that the total incomes as a function of inputs (investments, materials etc.) are also a linear or near linear function (Fig. 7 and Fig. 8) justifying the econophysics model we have proposed.

An example of applying of the economic amplifier model at manufacture level (microeconomic level) is given in figure 7, where the total incomes as a function of initial and annual investments and expenses are represented. As if can be seen from figure 7, the ratio between the output total incomes and the input total expenses (including investments), meaning, $\beta_{economic}$, has a monotonous rising dependence, near a straight line.

The economic amplifier model can be also very well applied on the macroeconomic level. A good example is given in figure 8 where the dependence of the Gross Domestic Product (G.D.P.) of Romania as a function of the capital accumulation between 1990-2005 years is represented. As it can be seen from figure 8, the resulting function has a near linear dependence. The medium value of 5.19 for the economic β at national level is calculed.

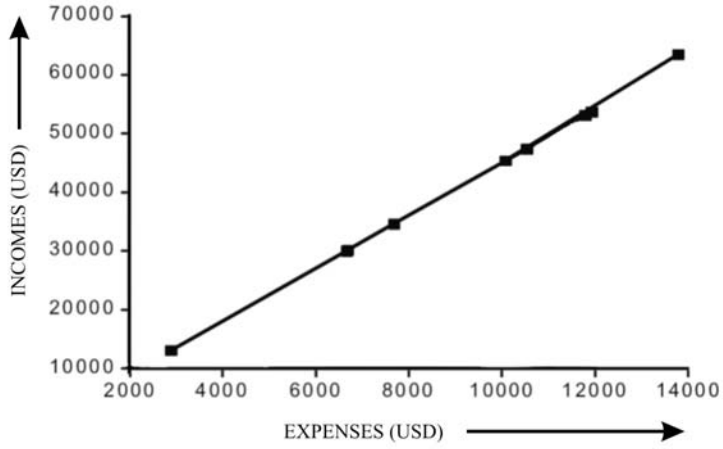


Figure 7. Incomes representation depending of expenses for a small manufacture.

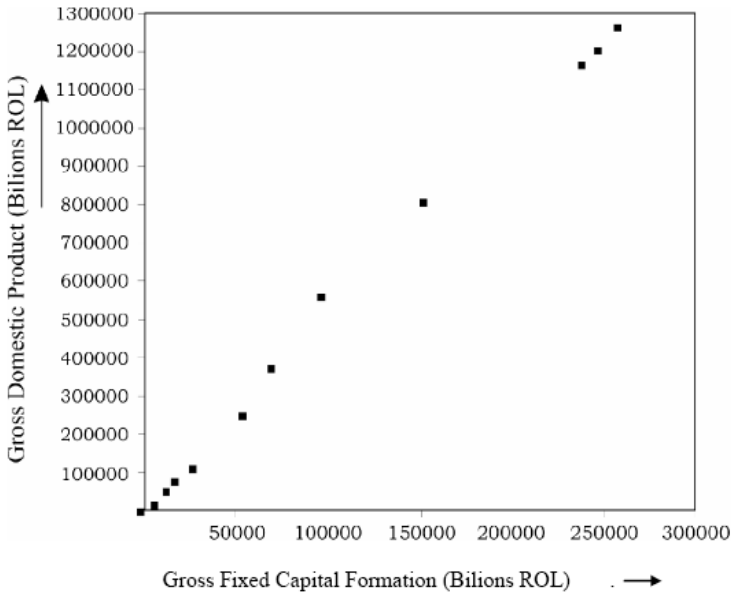


Figure 8. Gross Domestic Product of Romania vs. Gross Capital Formation for 1990-2005 period.

Apart from the normal development for which Incomes = f (Investments) dependence is a line or a monotonous rising curve, there are situations in which after a monotonous rising, the descending slopes appears signaling the appearance of the disturbing elements generated in special by human factor, damaging economic policies, crises, inefficient management or even political influences (totalitarian states). In such cases, when investments and equipment lifetime (T) had not been consumed, but the dependence isn't a line or a monotonous rising curve, the parameters on the basis of the investment must be reconsidered and any negative influences, restrictive policies etc. must be eliminated, in order to put the business on the normal trend of rising.

Such considerations may seem (appear) obvious or of good sense, but it is important to remind that all these are in concordance with economic amplifier model which we have proposed here.

6. Conclusions

A new econophysic model, on the basis of the amplification phenomenon from applied physics, that can be realized using transistors, integrated circuits or other electronic active devices, was proposed and analyzed.

This new model, named economic amplifier, can be used for modeling different economic structures or processes such as production or investment fields, steady capital, founds or financial-banking fields, stocks etc.

The accuracy of electronic transistor and of electronic amplifier functioning, confirmed through all nowadays supertechnology, can confer a solid guaranty for the economic amplifier model also in the economic fields where such model is applied.

As it shown in previosly papers [19,20], the economic amplifier model can explain and confirms the justness and validity of other econometric models from the investments field.

Unlike the static models derived from statistical physics, that can not show system evolution, the economic amplifier model is a dynamic one permitting to forecast the behavior of the economic system studied depending on some economical data applied on the "amplifier" input.

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DIAGONALIZATION PROBLEMS IN CLASSICAL MAXWELL THEORY AND THEIR INDUSTRIAL APPLICATIONS

Irina DMITRIEVA*

Abstract. *Present results concern the diagonalization problem of the arbitrary n-dimensional operator equations system over the arbitrary m-dimensional space. The known elements are the arbitrary operators that act in certain class. The only requirement of the proposed diagonalization method is the operators' commutativity in pairs. The proposed algorithm is invariant to the matrix structure of the initial system which may have the arbitrary block construction, and the diagonalizing procedure acts in the consecutive order beginning from the external till the last inner matrix block elements.Moreover, the given method doesn't depend on the initial and boundary conditions which become necessary only when the diagonalizing process is finished completely. Additionally, this algorithm deals only with the operators that form the matrix of the original system. Hence, these operators explicit expressions are known in advance and the described diagonalizing procedure "knows" beforehand what kind of operator and when it is applied.The proposed method and calculus, though are absolutely correct mathematically, are rather simple in their direct application and do not require from the engineer or some other non-expert the knowledge of the generalized function theory that is used almost in all diagonalization applied problems even for the usual linear PDEs systems.Thus, the present results in their specific case of the PDEs operator system over the classical Maxwell space were applied to the solution of concrete engineering problems that concerned the signal transmission in various media.*

Keywords: diagonalization, system of the PDEs operator equations, vector function, scalar equation, Maxwell space.

1. Introduction

It is well known that the majority of real physical processes may be described by the PDEs or by their systems**.** That's why even now the problem of simply applied and mathematically correct algorithm for the

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various classes of the PDEs systems' explicit solution remains quite urgent not only in the current physics and engineering, but in the applied mathematics as well [1]-[3]. The classical approach here is the method of integral transformations jointly with the generalized functions theory [2].

In the case of the first studied direction the original PDEs system after application of the corresponding integral transformation is reduced to the ODEs or algebraic equations system in terms of the initial functions' transformants. But when the applied problem is studied by means of the above mentioned method one must be very cautious in choosing the correct integral transformation. In other words, the integral transformation has to be chosen correctly not only mathematically but also considering physical or engineering features of the initial statement.

Turning towards the generalized functions method it should be noted that this approach, though is very elegant mathematically, remains rather difficult for the non mathematicians at the stage of its explicit realization. Thus, for example, in monograph [2, p. 127-201], even in the simple systems' case of the differential operator polynomials with constant coefficients from the very beginning the researcher has to deal with integral transformations which operate in various classes of the generalized functions, just as: basic, moderate and quickly increased. Hence, when an engineer or some other non expert even at the stage of system diagonal-lization procedure uses the both of the above mentioned methods, he must be very acute in all their mathematical details. Moreover, for each specific class of systems these approaches are realized in their own way [2].

With the problem of the PDEs first order systems' solution over the space (x, y, z, t) the author has come across investigating the classical electrodynamics objects and Maxwell equations in particular [4]. Thus, in [5] was considered the case of linear homogeneous isotropic undisturbed media with the outside currents, and only two main postulates of classical electrodynamics as the following vector equations were accepted:

$$\begin{cases} rot\vec{H} = \sigma\vec{E} + \varepsilon_a \partial_0 \vec{E} + \vec{j}^{CT} \\ -rot\vec{E} = \mu_a \partial_0 \vec{H} \end{cases} \tag{1}$$

In (1): $\vec{E} = \vec{E}(x, y, z, t)$ and $\vec{H} = \vec{H}(x, y, z, t)$ are the unknown vector functions of the electric and magnetic field tension; differential operator $\partial_0 = \frac{\partial}{\partial t}$; the given vector function $\vec{j}^{CT} = \vec{j}^{CT}(x, y, z, t)$ describes the outside current sources; the positive constants $\sigma, \mu_a, \varepsilon_a$ are the specific conductivity,

absolute permeance and dielectric permeability correspondingly. In [5] this vector system (1) was reduced to the equivalent system of six PDEs, and each equation held only one unknown scalar vector component $\vec{E} = \{E_i\}^3_{i=1}$ or $\vec{H} = \{H_i\}^3_{i=1}$. In other words, the original matrix system was diagonallized. Such result was obtained by the consistent application of the corresponding differential operators to six original equations of (1) that were written in terms of $\{E_i\}^3_{i=1}$ and $\{H_i\}^3_{i=1}$.

Further, in [6] the arbitrary 6×6 PDEs system, the "complete" Maxwell system (1), which matrix had no zero elements, was diagonalized by the generalization of the same algorithm.

In [7] the [5, 6] results were applied to the simple case of the differential operator block matrix.

2. The problem statement

In given paper we propose the generalization and analytical formalization of the previous results [5]-[7] in the case of the arbitrary *n*-dimensional differential operator systems over the arbitrary finite dimensional real space $\mathbb{R}^m$:

$$\sum_{i=1}^{n} A_{ji} F_i = f_j \quad (j = \overline{1,n}), \tag{2}$$

where: $\vec{F} = \vec{F}(x_1,...,x_m)$ and $\vec{f} = \vec{f}(x_1,...,x_m)$ are the *n*-dimensional unknown and given vector-functions that are $n \cdot s$ continuously differenttiated in some domain of $\mathbb{R}^m$; s is equal to the maximum order of the higher operators' A_{ji} derivative for all $j,i = \overline{1,n},$ and partial differential operators A_{ji} are utterly arbitrary. The only requirement of the proposed diagonalization procedure is their commutativity in pairs:

$$A_{ji} A_{kl} = A_{kl} A_{ji} \quad (j,i,k,l = \overline{1,n}), \tag{3}$$

where the consistent operators' application is defined as usual from the right to the left, i.e. from the "inner" to the "external"

We should remind now that diagonalization of (2) is treated here in the same meaning as usual. The initial system is reduced to the equivalent one that consists of n scalar partial differential operator equations, and every equation holds an only one component $F_i = F_i(x_1,...,x_m)$ $(i = \overline{1,n})$ of

the unknown vector function $\vec{F}$. This result is also obtained by the consistent application of the appropriate partial differential operators to the original equations of system (2).

3. The "upward" diagonalization stage

At the first diagonalization stage we raise a problem to obtain the scalar equation with respect to one of the unknown components $\{F_i\}_{i=1}^{n}$. Not breaking the common character of our results, we assume that the wanted component is F_1.

Step 1. We separate the last equation of system (2) and isolate the item with the scalar F_n in all n equations of the considered system:

$$\begin{cases} \sum_{i=1}^{n-1} A_{ji}F_i + A_{jn}F_n = f_j \\ \qquad\qquad\qquad\qquad (j=\overline{1,n-1}), \\ \sum_{i=1}^{n-1} A_{ni}F_i + A_{nn}F_n = f_n. \end{cases} \tag{4}$$

Then we apply to the last equation of (4) the operator:

$$(A_{jn}) \quad (j=\overline{1,n-1}) \tag{4′}$$

consistently for all j from (4′), and to the remained $n-1$ equations of the same system the following operator:

$$A_{nn} \tag{4″}$$

is applied. Afterwards we sum consistently the last transformed n th equation and the rest $n-1$ transformed equations for all $j=\overline{1,n-1}$. As the result we come to the system that is equivalent to (4), its equations from the first till the $(n-1)$ th have no anymore the scalar F_n and the n th equation is separate:

$$\begin{cases} \sum_{i=1}^{n-1} (A_{nn}A_{ji} - A_{jn}A_{ni})F_i = A_{nn}f_j - A_{jn}f_n \\ \qquad\qquad\qquad\qquad (j=\overline{1,n-1}), \\ \sum_{i=1}^{n-1} A_{ni}F_i + A_{nn}F_n = f_n. \end{cases} \tag{5}$$

Such separate equations that close the appropriate system at every diagonalization step further in this paper we shall call “the single equations”.

Introducing the auxiliary notations for given operators and functions:

$$\begin{aligned} &A_{nn}A_{ji} - A_{jn}A_{ni} = B_{ji}^{(1)} \\ &A_{nn}f_j - A_{jn}f_n = g_{j1} \end{aligned} \quad (j,i = \overline{1,n-1}), \tag{6}$$

we consider now only the first $n-1$ equations from (5), i.e. the subsystem of (5) that looks like:

$$\sum_{i=1}^{n-1} B_{ji}^{(1)} F_i = g_{j1} \quad (j = \overline{1,n-1}) \tag{7}$$

and that is the system (5) without its “single equation”.

Continuing the proposed procedure, at every consequent step we get the “subsystem” of the concluding system from the previous algorithm stage, i.e. the former final system without its “single equation”. Each of these new studied objects has by one component F_i less than it had at the preceding step. It should be remembered here that since at each step’s closing the “single equation” is rejected, hence, we can speak about the equivalence of the obtained systems only within the limits of certain algorithmic stage and only until the moment of temporary rejection of the corresponding “single equation”. Anyhow, it is obvious and will be completely evident at the end of the present part 3 that the sought for system which is equivalent to the initial system (2), will be obtained after the final step $k = n-1$ by the attaching to the last concluding scalar equation all the preceding “single” non-scalar ones that were rejected before.

Thus, generalizing the given method for all $k = \overline{1,n-1}$, we can write the resulting system of the k th step:

$$\sum_{i=1}^{n-k} B_{ji}^{(k)} F_i = g_{jk} \quad (j = \overline{1,n-k}) \quad (k = \overline{1,n-1}), \tag{8}$$

and consider the general:

Step $k+1$ **for** $\forall k = \overline{1,n-1}$. In all $n-k$ equations of system (8) we isolate the item with component F_{n-k}, and the last equation of (8) is written separately:

$$\begin{cases} \sum\limits_{i=1}^{n-k-1} B_{ji}^{(k)} F_i + B_{j,n-k}^{(k)} F_{n-k} = g_{jk} \\ \sum\limits_{i=1}^{n-k-1} B_{n-k,i}^{(k)} F_i + B_{n-k,n-k}^{(k)} F_{n-k} = g_{n-k,k} \end{cases} \quad (j = \overline{1,n-k-1}) \quad (k = \overline{1,n-1}). \tag{9}$$

Then we apply to the $(n-k)$ th equation of (9) the following operator:

$$(-B_{j,n-k}^{(k)}) \ \ (j=\overline{1,n-k-1}) \tag{9′}$$

consistently for all j from (9′), and to the rest $n-k-1$ equations of the same system the operator:

$$B_{n-k,n-k}^{(k)} \tag{9″}$$

is applied. Afterwards, we sum in the consecutive order the $(n-k)$ th transformed equation and the rest $n-k-1$ transformed equations from system (9) for all $j=\overline{1,n-k-1}$. As the result we come to the following system

$$\begin{cases} \sum\limits_{i=1}^{n-k-1}(B_{n-k,n-k}^{(k)}B_{ji}^{(k)}-B_{j,n-k}^{(k)}B_{n-k,i}^{(k)})F_i=B_{n-k,n-k}^{(k)}g_{jk}-B_{j,n-k}^{(k)}g_{n-k,k} \\ ----------(j=\overline{1,n-k-1}) \\ \sum\limits_{i=1}^{n-k-1}B_{n-k,i}^{(k)}F_i+B_{n-k,n-k}^{(k)}F_{n-k}=g_{n-k,k} \end{cases} \tag{10}$$

that is equivalent to (9). The first $n-k-1$ equations of (10) contain only components F_i $(i=\overline{1,n-k-1})$ and don't hold F_i $(i=\overline{n-k,n})$. The $(n-k)$ th equation of system (10) is "single".

Introducing the auxiliary notations for the appropriate certain operators and functions:

$$B_{n-k,n-k}^{(k)}B_{ji}^{(k)}-B_{j,n-k}^{(k)}B_{n-k,i}^{(k)}=B_{ji}^{(k+1)} \ \ (j,i=\overline{1,n-k-1}),$$

$$B_{n-k,n-k}^{(k)}g_{jk}-B_{j,n-k}^{(k)}g_{n-k,k}=g_{j,k+1} \ \ (j=\overline{1,n-k-1}) \tag{11}$$

we can rewrite the concluding system of the current step $k+1$, i.e. – (10) without its "single" equation:

$$\sum_{i=1}^{n-k-1}B_{ji}^{(k+1)}F_i=g_{j,k+1} \ \ (j=\overline{1,n-k-1}) \ \ (k=\overline{1,n-1}). \tag{12}$$

The known operators $B...$ and functions $g...$ from (12) are defined by the formulae (6), (11).

And at last the final:

Step $k = n - 1$ leads to the following: we substitute $k+1 = n-1 \Leftrightarrow$ $\Leftrightarrow k = n-2$ to (11), (12) and as the result obtain the wanted scalar equation with the component F_1:

$$B_{11}^{(n-1)} F_1 = g_{1,n-1}\,, \tag{13}$$

while the rest $n-1$ non scalar equations are "single". In (13) the corresponding given operator and function are described by the below written recurrent formulae that were got after the substitution of $k = n-2$ into (11):

$$B_{11}^{(n-1)} = B_{22}^{(n-2)} B_{ji}^{(n-2)} - B_{j2}^{(n-2)} B_{2i}^{(n-2)} \quad (j,i = 1),$$

$$g_{1,n-1} = B_{22}^{(n-2)} g_{1,n-2} - B_{12}^{(n-2)} g_{2,n-2}\,. \tag{14}$$

Here it should be noted that in (11), (12), (14) as everywhere in the present part 3, the upper index in round brackets of the known operator $B...$ and the second lower index of the known function $g...$ mean the step number of the diagonalization procedure in the "upward" direction.

Also we have to notice that even at the current stage of the only one scalar equation construction the commutativity in pairs (3) of the initial operators is strictly required. Otherwise the desired result can't be obtained. This evident fact follows directly from the realization of the proposed algorithm and does not depend on which side, left or right, the corresponding operators are applied to the considered system's equation.

At last, closing the part 3 which main purpose was attained in the formulae (13), (14), we can write the final system of the diagonalization procedure in the "upward" direction:

$$B_{11}^{(n-1)} F_1 = g_{1,n-1}, \tag{15}$$

$$\sum_{i=1}^{n-k} B_{ji}^{(k)} F_i = g_{jk} \quad (j = \overline{2, n-k};\ \ k = \overline{0, n-2}) \quad (*)$$

where:

$$B_{ni}^{(0)} = A_{ni} \quad (i = \overline{1, n}),\ \ g_{n0} = f_n, \ \text{when}\ \ k = 0, \tag{15′}$$

are the known appropriate operators and functions from the last equation of system (4) or (5). System $(15), (*)$ is got by attaching to the wanted scalar equation (15) all "single" equations that were rejected earlier. Therefore, the equivalence of $(15),\ (*)$ to the initial system $(2) \equiv (4)$ is obvious.

Additionally, it should be noted that the arrow direction for the index k from formula $(*)$ till the very end of the next part 4 will describe the

backward counting, – from the right to the left System (15), $(*)$ represents the completion of the "upward" diagonalization stage.

4. The "downward" diagonalization stage

Now we are going to propose the second diagonalization stage that works in the opposite – "downward" direction.

Step 1 ($k = n - 2$). We isolate the first equation of subsystem $(*)$ and write it together with the obtained scalar equation (15) that holds the component F_1. At this moment we neglect the rest $k = \overline{0, n-3}$ equations from $(*)$ considering them as "single":

$$\begin{cases} B_{11}^{(n-1)} F_1 = g_{1,n-1} \\ \sum\limits_{i=1}^{2} B_{ji}^{(n-2)} F_i = g_{j,n-2} \, (j = 2). \end{cases} \tag{16}$$

In the last equation of (16) we separate the item with scalar F_2:

$$\begin{cases} B_{11}^{(n-1)} F_1 = g_{1,n-1} \\ B_{21}^{(n-2)} F_1 + B_{22}^{(n-2)} F_2 = g_{2,n-2}, \end{cases} \tag{17}$$

apply to the second and first equations from (17) the appropriate operators:

$$B_{11}^{(n-1)}, \tag{17′}$$

$$(-B_{21}^{(n-2)}) \tag{17″}$$

and sum up the both transformed equations.

After (17)'s transformation that dealt with operators (17′), (17″), we come to the following system:

$$\begin{cases} B_{11}^{(n-1)} F_1 = g_{1,n-1} \\ B_{11}^{(n-1)} B_{22}^{(n-2)} F_2 = B_{11}^{(n-1)} g_{2,n-2} - B_{21}^{(n-2)} g_{1,n-1}, \end{cases} \tag{18}$$

which is equivalent to (17) and where the second scalar equation with the component F_2 appears.

Introducing the auxiliary notation for the known function from the right part of the last equation in system (18):

$$B_{11}^{(n-1)} g_{2,n-2} - B_{21}^{(n-2)} g_{1,n-1} = h_1, \tag{19}$$

we rewrite (18) as follows:

$$\begin{cases} B_{11}^{(n-1)} F_1 = g_{1,n-1} \\ B_{11}^{(n-1)} B_{22}^{(n-2)} F_2 = h_1. \end{cases} \tag{20}$$

It is clear that after getting formulae (20), the subsystem $(*)$ has lessened by one equation and looks like:

$$\sum_{i=1}^{n-k} B_{ji}^{(k)} F_i = g_{jk} \quad (j = \overline{3, n-k};\ k = \overleftarrow{0, n-3}). \quad (*_1)$$

Indices of the given functions *h...* from (19) and everywhere in the present part part 4 imply the step number of the second – "downward" diagonalization stage.

Further, the generalization of the current diagonalization stage in the case the arbitrary step l $(l = \overline{1, n-1})$ is considered. At first, we write the subsystem $(*_{l-1})$ of the previous step $l-1$:

$$\sum_{i=1}^{n-k} B_{ji}^{(k)} F_i = g_{jk} \quad (j = \overline{l+1, n-k};\ k = \overleftarrow{0, n-l-1}). \quad (*_{l-1})$$

When $l = 1$, the second equation of system (16) corresponds to the "zero" step.

As it was done earlier in the part 4, we isolate the first equation in $(*_{l-1})$ and attach it to the concluding system of scalar equations from the preceding step $l-1$. Simultaneously, the remained $k = \overleftarrow{0, n-l-2}$ equations in $(*_{l-1})$ are "single".

The system which last equation will be reduced to a scalar one is obtained earlier and looks like:

$$\begin{cases} \prod_{q=1}^{p+1} B_{qq}^{(n-q)} F_{p+1} = h_p \\ \sum_{i=1}^{l+1} B_{ji}^{(n-l-1)} F_i = g_{j,n-l-1} \end{cases} \quad (p = \overline{0, l-1};\ h_0 = g_{1,n-1};\ j = l+1). \tag{21}$$

The symbol of finite operator product in (21) and later in the present part 4 implies the usual consequent operator application from the inner to the external in "the right to the left" direction.

Further, we separate in the $(l+1)$ th equation of (21) the item with the component F_{l+1}:

$$\begin{cases} \prod_{q=1}^{p+1} B_{qq}^{(n-q)} F_{p+1} = h_p \\ \sum_{i=1}^{l} B_{l+1,i}^{(n-l-1)} F_i = g_{l+1,n-l-1} \end{cases} \quad (p = \overline{0, l-1};\ \ h_0 = g_{1,n-1}) \tag{22}$$

and apply to the last equation from (22) the operator:

$$\prod_{q=1}^{l} B_{qq}^{(n-q)} . \tag{22′}$$

To the remained equations in (22) from the first till the $(l-1)$ th we apply the appropriate operators

$$(-B_{l+1,r}^{(n-l-1)} \prod_{q=r+1}^{l} B_{qq}^{(n-q)}) \ \ (r = \overline{1, l-1}), \tag{22″}$$

and the l th equation of the same system is transformed by the operator:

$$(-B_{l+1,l}^{(n-l-1)}) . \tag{22‴}$$

Then we sum up all these $l+1$ transformed equations and obtain the system:

$$\begin{cases} \prod_{q=1}^{p+1} B_{qq}^{(n-q)} F_{p+1} = h_p \\ \prod_{q=1}^{l+1} B_{qq}^{(n-q)} F_{l+1} = \prod_{q=1}^{l} B_{qq}^{(n-q)} g_{l+1,n-l-1} - \sum_{r=1;(l\neq 1)}^{l-1} B_{l+1,r}^{(n-l-1)} \prod_{q=r+1}^{l} B_{qq}^{(n-q)} h_{r-1} - B_{l+1,l}^{(n-l-1)} h_{l-1} \end{cases}$$

$$(p = \overline{0, l-1}), \tag{23}$$

that is equivalent to (22). In the case of $l=1$ the second item in the right part of the last equation from (23) is assumed to be equal to zero, and $h_0 = g_{1,n-1}$.

Introducing the common notation for the known function from the right part of the last equation in (23):

$$h_l = \prod_{q=1}^{l} B_{qq}^{(n-q)} g_{l+1,n-l-1} - \sum_{r=1;(l\neq 1)}^{l-1} B_{l+1,r}^{(n-l-1)} \prod_{q=r+1}^{l} B_{qq}^{(n-q)} h_{r-1} - B_{l+1,l}^{(n-l-1)} h_{l-1} , \tag{24}$$

we can write the final system (23) of the arbitrary step l $(l=\overline{1,n-2})$ as follows:

$$\prod_{q=1}^{p+1} B_{qq}^{(n-q)} F_{p+1} = h_p \quad (p=\overline{0,l};\ h_0 = g_{1,n-1}), \tag{25}$$

and the second item from the right part of (24) is equal to zero when $l=1$.

The obtained recurrent formulae (24), (25) are easily verified, e.c. for the above mentioned step $l=1$.

It should be noted that after the construction of (25) the subsystem $(*_{l-1})$ decreases by one equation (the initial subsystem $(*)$ – correspondingly by l) and turns into the following:

$$\sum_{i=1}^{n-k} B_{ji}^{(k)} F_i = g_{jk} \quad (j=\overline{l+2,n-k};\ k=\overline{0,n-l-2}). \tag{$*_l$}$$

After continuation of the "downward" diagonalization stage including the final step $l=n-1$, we come to the sought for scalar equations' system with all components F_i $(i=\overline{1,n})$ (look (25) when $l=n-1$):

$$\prod_{q=1}^{p+1} B_{qq}^{(n-q)} F_{p+1} = h_p \quad (p=\overline{0,n-1};\ h_0 = g_{1,n-1}), \tag{26}$$

where the definite operators and functions are described by formulae (11) and (24) from the parts 3 and 4 correspondingly.

When the explicit construction of the resulting system (26) is finished we can assert that the subsystem of "single" equations $(*_l)$ does not exist anymore, since after completion of the preceding step $l=n-2$ the subsystem $(*_l)$ consisted of one equation:

$$\sum_{i=1}^{n-k} B_{ji}^{(k)} F_i = g_{jk} \quad (j=\overline{n,n-k};\ k=0)$$

$$\Updownarrow$$

$$\sum_{i=1}^{n} B_{ni}^{(0)} F_i = g_{n0}. \quad (*_{n-2})$$

In $(*_{n-2})$ the given operator $B...$ and function $g...$ are from formulae (15′). The next final step $l=n-1$ brings $(*_{n-2})$ to the sought for scalar equation with component F_n.

At the end of present part 4 we must mark the equivalence of the desired scalar equations' system (26) and the initial system (15), $(*)$. Therefore, the both mentioned systems are equivalent to the original system (2). This fact follows directly from the proposed diagonalization procedure and completes it. Thus, the existence of the initial operator system solution in terms of diagonalization is proved and the main purpose of given paper is attained.

In other words, the results of the parts 3, 4 and the final conclusion may be formulated as the following

Theorem. *The explicit solution of the system (2), (3) in terms of the diagonalization procedure exists and may be obtained algorithmically.*

5. Concluding remarks

In the conclusion of given paper it should be noted that the proposed diagonalization procedure doesn't need any concrete initial and boundary conditions which become necessary only when the obtained scalar equations have to be solved, i.e. when the diagonalization algorithm is finished completely. Also we have to remind that the general approach from the parts 3, 4 doesn't require any additional conditions in the original system (2), excepting the operator commutativity in pairs (3). Besides, the proposed method may be applied to the matrix operators of the arbitrary block structure. In this case we construct the diagonalized block matrix at first, then apply the diagonalization procedure from the block-to-block consistently and from the external operator elements to the inner ones, until we obtain the unknown scalar equations with the components of the original vector function $\vec{F}$.

In other words, the considered method doesn't depend neither on the operator matrix structure nor on the initial and boundary conditions of the studied problem (2) and represents the differential operator analogue of the algebraic systems' solution.

Additionally, and it is the last our remark, it should be noted that the proposed algorithm deals only with the operators which form the matrix of the original system. Hence, these operators explicit expressions are known in advance and the described diagonalizing procedure knows beforehand what kind of the operator and when it is applied.

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STATISTICAL THINKING AND STATISTICAL PHYSICS

Gheorghe SĂVOIU*

Abstract. *This paper presents a framework for the design and analysis of Statistics as a scientific way of thinking. Contemporary Statistics for economists and for physicists are not complete or harmonized disciplines. Models for statistical ways of thinking and problem solving have been developed, and continue to be developed, not only by teachers but also by scientific researchers / practitioners. Today it becomes possible for method and concepts of statistical physics to have real influence in statistical thinking or economic thinking, but it is also possible that economical and classical statistical methods and concepts can influence physics thinking too. In a comparison to classical statistical thinking, a new science like Econophysics – primarily focused on analysis of financial markets and its important achievements defining new statistical mechanics of money distribution – have revealed that heterogeneous in reality must be explained with homogeneous in theory. Econophysics will continue to contribute due to its statistical physics method to statistical and economic thinking in a variety of distinctive directions, ranging from macroeconomics to market microstructure. A modern book of Statistics must contain statistical physics and statistical quantum approaches too. Finally, this is another role of this paper to underline the importance of the method of statistical physics to unify and simplify statistical thinking for economist, physicists and econophysicists.*

Keywords: statistics, physics, econophysics, statistical way of thinking, statistical physics, method of statistical physics.

1. Introduction

Specific economic theories are constructed from rationality which is the same thing as maximizing expected utility by applying the basic postulates to various economic situations. The new science called Econophysics by Rosario Mantegna and H. Eugene Stanley at the second Statphys-Kolkata conference (Chakrabarti BK, 2005), in 1995, follows the path of care mergers as astrophysics, biophysics, geophysics etc. and it is based on the observation of similarities between economical systems and concepts and those from physics, using the methods from statistical physics. There is

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nothing new in the close relationship between physics and economics. A lot of the great economists did their original training and took their models in and from physics, and the influence of physics is clearly evident in many of economic theory's models. But it is well known too that physics had the more dominating effect on the development of formal economic theory. Its molecular statistical theory of thermal phenomena, furthered the cause of mechanical atomism and population-based thinking. The empirical and theoretical impact of the relativistic and quantum frameworks of physics cemented new, deeper boundaries. Relativity captured space, time and gravitational interacttion; quantum mechanics, matter and the rest of forces (*Stanford Encyclopedia of Philosophy*). The adequate use for concepts and methods of population-thinking in economics and the role of the environment have been developed to study a new kind of complex dynamical system like the economical or the financial one. The relation that has transpired between economics and physics, in the over past two decades seems very likely to be a model for the future, and the purpose of this paper is to identify the potential of Econophysics through its new domains and results.

2. What is the adequate meaning for statistical thinking?

Some of the main techniques used by Statistics were initially developed by mathematicians, and some of the first ideas and models of thinking associated with economists were developed by statisticians. Many economists try to use statistical models too, for the study of a broader variety of economic phenomena's trends and dynamics. Models for statistical ways of thinking and problem solving have been developed, and continue to be developed, by teachers and researchers or practitioners. All the introductory courses in Statistics, are designed not only to provide the student with the basic concepts and methods of statistical analysis for product and processes, but even for developing a scientific way of thinking and these contain: the need for data and information; the importance of data production and indices or indicators; the omnipresence of variables and variability in the processes; the utilization of a scale for measuring and modeling of variability, the importance of testing hypothesis; the inference from a selected part (sample) to the all investigated population; the final explanation of variation etc.

Special mental habit always characterized professional statisticians, and never the amateurs in scientific researches. These distinctive habit is a broad and a very precisely view, or overall framework, in which to put a particular problem (of phenomena's variation).

Some econophysicists seek to integrate their findings with classical Statistics' theory and statistical thinking, but many others, seeing it as useless and limited, seek to replace its conventional way, with the new and broader view of Statistical Physics thinking.

3. What is the adequate meaning for contemporary econophysics and for econophysics' thinking?

The field of research known as Econophysics, has alternative names like Financial physics and Statistical finance and this only for being initially a new development of two different disciplines like Finance and Physics. But in the last few years, more and more work has been done outside the field of Finance. Rosario Mantegna and Eugene H. Stanley have proposed the first definition of Econophysics as a multidisciplinary field or "the activities of physicists who are working on economics problems to test a variety of new conceptual approaches deriving from the physical sciences" (Mantegna RN, Stanley HE, 2000).

From the classical Physics side, Econophysics is mainly considered to be restricted to the principles of statistical mechanics, which is the application of probability theory to large numbers of physical objects which are related to each other in a certain way, while from the Economics site, macroscopic properties are viewed as the result of interactions at the microscopic level of the constituents, and Econophysics becomes for economists which have always encouraged the application of quantitative and formal methods "the investigation of economic problems by physicists" (Roehner B, 2005). But somehow the Econophysics is more interesting viewed by its practitioners, as a revolutionary reaction to standard economic theory that threatens to enforce a paradigm shift in thinking about economic systems and phenomena. Yakovenko relevant definition considers that Econophysics is an "interdisciplinary research field applying methods of statistical physics to problems in economics and finance" (Yakovenko VM, 2007).

Econophysicists, making use of the statistical physics analogy, rather than a thermo dynamical one, adopt a constructive-theory-type approach. And thus their without prior models are microscopically realistic, and where the parameters hold some physical meaning that are derived from the data and are physically well-founded by providing basic mechanisms for the phenomena. Modern Econophysics, a very rapidly developing area, proposes the application of methods from statistical physics, the physics of complex systems and science of networks to macro/micro-economic modeling, financial market analysis and social problems (from

demographical to cultural, from real economical convergence to social cohesion problems, etc.).

Contemporary Econophysics' thinking using new perspective, applies to economic phenomena various models and concepts associated with the physics of complex systems (e.g. statistical mechanics, condensed matter theory, self-organized criticality, microsimulation etc.) Econophysics' new way of thinking becomes more and more a translation of the Statistical Physics into real individuals and economic reality. Where the curious statistical properties of the data are fairly well-known amongst economists, but still remain a puzzle for economic theory, that will be the right place where physicists must come on stage lights with their method and techniques, and so they are defining a new model of thinking. For econophysicists, the universality of the statistical properties is their starting point, and for this new and stable vision of the truth, the most recently awarded Nobel Prizes, in the last decade, recognize outstanding original contributions that use statistical physics' methods to develop a better understanding of socio-economic problems.

The interest of physicists in financial and economic systems has roots that date back to 1936, when Majorana wrote a pioneering paper, published in 1942 and entitled *Il valore delle leggi statistiche nella fisica e nelle scienze sociali*, on the essential analogy between statistical laws in physics and social sciences. Many years later a statistical physicist Elliott Montroll coauthored with Badger W.W, in 1974, the book *Introduction to Quantitative Aspects of Social Phenomena.*

The application of concepts as power-law distributions, correlations, scaling, unpredictable time series and random processes to financial markets was possible during the past two or three decades years, because physicists have achieved important results in statistical mechanics, nonlinear dynamics, and disordered systems, and other significant results from their investigations and mathematical formalizations. Since the 1970s, a series of significant changes has taken place in the world of finance that finally will be born the new scientific field of Econophysics. One key year was 1973, when currencies began to be traded in financial markets, and it was published the first paper that presented a rational option-pricing formula (Black & Scholes, 1973)[1]. Another evolution in Econophysics' thinking began in the 1980s, when electronic trading was adapted to the foreign exchange market and the result have became a huge amount of electronically stored financial data readily available. Since the same 1980s it has been recognized in the physical sciences that unpredictable time series and stochastic processes are

not synonymous. The chaos theory has shown that unpredictable time series can arise from deterministic nonlinear economic systems and theoretical and empirical studies have investigated whether the time evolution of asset prices in financial markets might indeed be due to underlying nonlinear deterministic dynamics of a limited number of variables. Since the 1990s, a growing number of physicists have attempted to analyze and model financial markets and, more generally, economic systems, new interdisciplinary journals have been published, new conferences have been organized, and a lot of new potentially scientific fields, areas, themes and applications have been identified. The researches of Econophysics deal with the distributions of returns in financial markets, the time correlation of a financial series, the analogies and differences between price dynamics in a financial market and physical processes as turbulence or ecological systems, the distribution of economic stocks and growth rate variations, the distribution of firm sizes and growth rates, the distribution of city sizes, the distribution of scientific discoveries, the presence of a higher-order correlation in price changes motivated by the reconsideration of some beliefs, the distribution of income and wealth, the studies of the income distribution of firms and studies of the statistical properties of their growth rates.

The statistical properties of the economic performances of complex organizations such as universities, regions or countries have also been investtigated in Econophysics. The new real characteristics of the Econophysics on medium and long term, will be a result of its new research like rural-urban migration or growth of cities, etc. The real criticism of Econophysics is the absence of age variable, because models of Econophysics consider immortal agents who live forever, like atoms, in spite of evolution of income and wealth as functions of age, that are studied in economics using the so-called overlapping-generations models (Paul Anglin). Even with the time, both physics and economics became more formal and rigid in their specializations, and the social origin of statistical physics was forgotten, the future is perhaps a common one.

On the computer econophysicists have established a niche of their own by making models much simpler than most economists now choose to consider even using possible connection between financial or economical terms and *critical points* in Statistical Mechanics, where the response of a physical system to a small external perturbation becomes infinite because all the subparts of the system respond cooperatively, or the concept of “noise” in spite of the fact that some economists even claim that it is an insult to the intelligence of the market to invoke the presence of a noise term…

Here three other interesting typical Econophysics' models and new examples are:

– the derivation of a price's distribution in the stock market (the change in the price "*x*" of stock market could be considered a random among dealers, then can derive a diffusion equation as a Brownian motion, for distribution *f*(*x, t*) of price in the stock market) [2]:

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

distributions of the form that follows a power law as: $\ln p(x) = -\alpha \ln x + C$, where the constant α is called exponent of the power law, and C is constant and mostly uninteresting (once α is fixed, it is determined by the requirement of normalisation to 1), or in the case of taking the exponential of both sides, this is equivalent to: $p(x) = Cx^{-\alpha}$ (a power-law distribution occurs in an extraordinarily diverse range of phenomena such as Finance, Macroeconomics, Demography's urbanism) [3]

a) a fractal and chaos analysis originating as Benoite Mandelbrot pointed out that the change in the price of the stock market has a fractal structure for certain range of time interval [4, 5], and characterized as a self-similar structure expressed as: $x(t) = Ct^D$, where D is a fractal dimension, calculated by the box counting method. (The fractal structure is special case of a chaos and chaotic behavior is very common in a non-linear system as for an economic system; whether the process is chaotic or not can be determined by sign of Lyapunov index λ defined as: $\lambda = 1/n \, \Sigma \log | F'(t) |$, and when λ is positive (negative) then the process is chaotic (non-chaotic). [2]

Many different methods and techniques from physics and the other sciences have been explored by econophysicists, sometimes frantically, including chaos theory, neural networks and pattern recognition.

Econophysics' new way of thinking means also a new scientific approach to quantitative economy using ideas, models, conceptual and computational methods of Statistical Physics, Statistical Mecanics, Quantum Physics etc.

In recent years many of physical theories like theory of turbulence, scaling, random matrix theory or renormalization group were successfully applied to economy giving a boost to modern computational techniques of data analysis, risk management, artificial markets, macro-economy and thus Econophysics became a regular discipline covering a large spectrum of problems of modern economy.

But even today in this new era of Econophysics still remains a negative impact of physics with economics for which both physicists and

economists are in part responsible, because of the failure of economists to deal properly with certain empirical regularities and a lot of economists still have a mind set which is unusually closed, or it is caused by the fact that many physicists cannot understand even the simplest supply-and-demand model, or by the fact that physicists and economists belong to the distinct categories of physical or natural (hard) science and social (soft) etc. Science or financial markets are only a very small part of economic theory and some physicists naively believe and search for universal empirical regularities in economics that probably do not exist and seem to have been reluctant to work in areas where data sets are short and unreliable, but this characterizes a great deal of data in the social sciences and economics.

4. Statistical physics the old method of econophysics

The contemporary Econophysics involves in effect physicists doing economics with theories from physics, and this raises the question of how the two disciplines relate to each other and it explains interest rates and fluctuations of stock market prices, these theories draw analogies to earthquakes, turbulence, sand piles, fractals, radioactivity, energy states in nucleus, and the composition of elementary particles (Bouchaud). Today it becomes possible for methods and concepts of statistical physics to have real influence in economic thought, but it is also possible that economical methods and concepts can influence physics thought too. The method of Econophysics defines its main goal in applying method of statistical physics and other mathematical methods used in physics to economic data and economic processes. Why the methods and techniques from statistical physics can be successfully applied to social, economical and financial problems? Could be this the result of the great experience of physicists in working with experimental data gives them a unique advantage to uncover quantitative laws in the statistical data available in social sciences, economics and finance? Is indeed Econophysics bringing new insights and new perspectives, which are likely to revolutionize the old social sciences and classical economics?

The study of dynamical systems is mostly based in expressing them in terms of (partial) differential equations which are further solved by analytic methods (or numerically). But this is somehow against our intuitions: we never meet in our life density distributions of our friends, cars, utility functions etc. We have converted integers into a real numbers by averaging over certain areas. This can be done either by averaging over large enough volumes or over long period of times. Statistical physics is a

framework that allows systems consisting of many heterogeneous particles to be rigorously analyzed. Inside Econophysics these techniques are applied to economic particles, namely investors, traders, consumers, and so on. Markets are then viewed as (macroscopic) complex systems with an internal microscopic) structure consisting of many of these particles interacting so as to generate the systemic properties (the microstructural components being reactive in this case, as mentioned already, thus resulting in an adaptive complex system).When the first physicists tried to analyze financial markets applying method of statistical physics they did not view these markets as particularly fine examples of complex systems, as cases of complexity in action. Some of them have even believed they are discovering laws or some stability evidence in the form of the scaling laws that Pareto first investigated (but that have been found in a much wider variety of economic observables). In truth, the stability evidence discovered or the empirical distribution is not a stable or definitive one (a conclusive one), because all the markets are characterized by non-stationarity, that is a general feature of adaptive complex systems: "the empirical distribution is not fixed once and for all by any law of nature [but] is also subject to change with agents' collective behaviour" (McCauley JL, 2004). Theory confirms that characteristics of complex systems involve three necessary conditions:

– complex system must contain many subunits (the exact number being left vague)

– subunits must be interdependent (at least some of the time)

– interactions between the subunits must be nonlinear (at least some of the time).

These properties are said to be emergent when they amount to new complex or systemic structure and an adaptive complex system add the following condition:

– individual subunits modify their properties and behaviour with respect to a changing environment resulting in the generation of new systemic properties.

Finally the organizing adaptive complex system also add an important condition:

– individual subunits modify their own properties and behaviour with respect to the properties and behaviour of the unit system they jointly determine (Latora & Marchiori, 2004).

In a comparison to classical statistical thought, Econophysics have revealed that heterogeneous in reality must be explained with homogeneous in theory. And this is the main role of method of statistical physics to unify and simplify economics.

5. Review of major results of econophysics' thinking

From the perspective of the way of thinking, the main Econophysics' elements for an update review remain the results in refereed literature. In the last only three to five years, an inventory for new domains of Econophysics it is really amazing. Thus Econophysics deals with more and more economical and non economical subjects:

1. A thermodynamic formulation of economics (J. Mimkes),
2. Zero-Intelligence models of limit order markets (R. Stinchcombe),
3. Understanding and managing the future evolution of a competitive multi-agent population (D. M. D. Smith and N. F. Johnson),
4. Firms' growth and networks (Y. Fujiwara, H. Aoyama, W. Souma),
5. A review of empirical studies and models of income distributions in society (P. Richmond, S. Hutzler, R. Coelho, P. Repetowicz),
6. Models of wealth distributions – a perspective (A. KarGupta),
7. The contribution of money transfer models to economics (Y. Wang, N. Xi, N. Ding),
8. Fluctuations in foreign exchange markets (Y. Aiba, N. Hatano),
9. Econophysics of stock and foreign currency exchange markets (M. Ausloos),
10. A thermodynamic formulation of social science (J. Mimkes),
11. Computer simulation of language competition by physicists (C. Schulze, D Stauffer)
12. Social opinion dynamics (G. Weisbuch),
13. Opinion dynamics, minority spreading and heterogeneous beliefs (S. Galam),
14. Global terrorism versus social permeability to underground activeties (S. Galam),
15. How a hit is born: the emergence of popularity from the dynamics of collective choice (S. Sinha, R. Kumar Pan),
16. Crowd dynamics (A. Johansson, D. Helbing),
17. Complexities of social networks: a physicist's perspective (P. Sen),
18. Emergence of memory in networks of non-linear units: from neurons to plant cells (J. Inoue),
19. Self-organization principles in supply networks and production systems (D. Helbing, T. Seidel, S. Lämmer, K. Peters),
20. Can we recognize an innovation? Perspective from an evolving network model (S. Jain, S. Krishna),

21. Econophysics of precious stones (Watanabe, N. Uchida, N. Kikuchi),

22. Econophysics of interest rates and the role of monetary policy (Daniel O. Cajueiro, Benjamin M. Tabak),

23. Quantum Econophysics (Esteban Guevara),

24. Inverse Statistics in Econophysics (K. H. Andersen),

25. Superstatistics in Econophysics (Y. Ohtaki, H. H. Hasegawa),

26. Statistical mechanics of money (A. A. Dragulescu and V. M. Yakovenko),

27. Lies and Statistics (G Price),

28. The Production Function (G. Fioretti)

29. How the rich get richer (A. Mehta, A. S. Majumdar, J. M. Luck),

30. The Emergence of Bologna and its Future Consequences. Decentralization as Cohesion Catalyst in Guild Dominated Urban Networks (R. E. Zimmermann, A. Soci),

31. Basel II for Physicists: A Discussion Paper (E. Scalas),

32. Advertising in Duopoly Market (S. Hokky),

33. Asymptotic behavior of the Daily Increment Distribution of the IPC, the Mexican Stock Market Index (H. F. Coronel-Brizio, A. R. Hernandez-Montoya),

34. On fitting the Pareto-Levy distribution to stock market index data: selecting a suitable cutoff value (H. F. Coronel-Brizio, A.R. Hernandez-Montoya),

35. Laser Welfare: First Steps in Econodynamic Engineering (G. Willis),

36. Stability through cycles (E. A. Groot),

37. Agent-based Model Construction in Financial Economic System (S. Hokky, Y. Surya),

38. The Process of price formation and the skewness of asset returns (S. Reimann),

39. Scale-free avalanche dynamics in the stock market (M. Bartolozzi, D. B. Leinweber, A.W. Thomas),

40. A Trade-Investment Model for Distribution of Wealth (N. Scafetta, BJ. West, S. Picozzi),

41. Tobin tax and market depth (G. E. F. Westerhoff, D. Stauffer),

42. Complex Systems, Information Technologies and Tourism: A Network Point of View (B. Rodolfo),

43. Socioeconomic Interaction and Swings in Business Confidence Indicators (M. Hohnisch, S. Pittnauer, S. Solomon, D. Stauffer),

44. Statistical Laws in the Income of Japanese Companies (T. Mizuno, M. Katori, H. Takayasu, M. Takayasu),

45. Ideal Gas-Like Distributions in Economics: Effects of Saving Propensity (B. K. Chakrabarti, A. Chatterjee),

46. Are Pound and Euro the Same Currency? (R. Matsushita, A. Santos, I. Gleria, A. Figueiredo, S. Da Silva),

47. Nonextensive statistical mechanics and economics (C. Tsallis, C. Anteneodo, L. Borland, R. Osorio),

48. What Economists can learn from physics and finance (McCauley, L. Joseph),

49. Statistical Entropy in General Equilibrium Theory (P. Liossatos),

50. The Political Robustness in Indonesia (S. Hokky),

51. Accelerated growth of networks (S. N. Dorogovtsev, J. F. F. Mendes),

52. Patterns, Trends and Predictions in stock market indices and foreign currency exchange rates (M. Ausloos, K. Ivanova),

53. Physics of Personal Income (W. Souma),

54. Predictability of large future changes in a competitive evolving population (D. Lamper, S. Howison, N. Johnson),

55. Correlations between the most developed (G7) countries. A moving average window size optimisation (J. Miskiewicz, M. Ausloos),

56. Herding to A Side of Order Book Balance (S. Hokky and S. Yohanes),

57. Growth and Allocation of Resources in Economics: The Agent-Based Approach (E. Scalas, M. Gallegati, E. Guerci, D. Mas, A. Tedeschi),

58. Power-law distribution in Japanese racetrack betting (I. Takashi),

59. Uncovering the Internal Structure of the Indian Financial Market: Cross-correlation behavior in the NSE (S. Sinha, R. K. Pan),

60. How a "Hit" is Born: The Emergence of Popularity from the Dynamics of Collective Choice (S. Sinha, R. K. Pan),

61. Inferring the Composition of a Trader Population in a Financial Market (N. Gupta, R. Hauser, N. F. Johnson),

62. The Why of the applicability of Statistical Physics to Economics (E. Guevara),

63. A Brief History of Economics: An Outsider's Account (B. K. Chakrabarti),

64. Around the gap between the sociophysics and the sociology (K. Kulakowski),

65. Network of Econophysicists: a weighted network to investigate the development of Econophysics (Ying Fan, Menghui Li, Jiawei Chen, Liang Gao, Zengru Di, Jinshan Wu),

66. Trading Behavior and Excess Volatility in Toy Markets (M. Marsili, D. Challet, R. Zecchina),

67. From Minority Games to real markets (D Challet, A Chessa, M. Marsili and Y-C Zhang),

68. Stylized facts of financial markets and market crashes in Minority Games (D Challet, M Marsili, YC Zhang),

69. Comment on Thermal model for adaptive competition in a market (D Challet, M Marsili, R Zecchina),

70. Comment on: Role of Intermittency in Urban Development (M. Marsili, S. Maslov, Y.-C. Zhang),

71. Dynamical Optimization Theory of a Diversified Portfolio (M. Marsili, S. Maslov, Y.-C. Zhang),

72. A prototype model of stock exchange (G. Caldarelli, M. Marsili, Y. C. Zhang),

73. Scaling in currency exchange (S. Galluccio G. Caldarelli, M. Marsili, Y. C. Zhang),

74. A moving-average-minimal-path-length method for UE country clustering according to macroeconomic fluctuations (M. Gligor, M. Ausloos),

75. Clusters in weighted macroeconomic networks: the EU case (M. Gligor, M. Ausloos),

76. A cluster-based analysis of some macroeconomic indicators in various time windows (M. Gligor, M. Ausloos) etc.

Econophysics will continue to contribute to Economics and Statistics development in different directions, due to its new Statistical Physics' way of thinking and its specific methods, ranging from macroeconomics to market microstructure, and that such work will have increasing implications for economic policy making with statistical instruments for better decisions.

6. Conclusions

Within the next few years Econophysics will be expected to develop new methods in understanding economical processes generating new disciplines like demographysics, indexphysics or physicalprognosis, in a so called economical and physical interaction with other sciences. The new most important domain must be demographysics (international migration), some special area of marketing and management, some distinctive field of index numbers (from poverty index to corruption or globalization index, from Consumer Price Index to Dow Jones Industrial Average etc.) and most of all to prognosis or spatial and temporal estimation. The accuracy of physical indices could be improved by statistical physics with its careful

thinking in terms of dimensional analysis, combined with better data analysis correlating prices and other factors to the phenomena, such as wages and pensions, for which the indices are designed. To understand the dynamics and Statistical Physics of agency promises to be the key to expand concepts from Statistics and Economics in Physics too. Econophysics will be expected to develop the classical statistical thinking too… New approaches will appear in Universities too. New basic course must teach the essential elements of both Physics and Economics or Statistics in the new curricula.

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DESCRIPTION AND ANALYSIS OF FUZZY INFORMATION

Wolfgang ECKER-LALA*

1. Overview

Results of measurements and observations are important information. This information is even more than only numbers or numerical vectors. One of the problems are that a lot of information is imprecise or fuzzy.

Even in the 15th century Nikolaus von Kues (Cusanus) stated the "basically non-avoidable impreciseness of measurements". The physician Robert von Mayer (1814-1878) said that numbers are the basis of an "exact science". Galileo Galilei asked for "measure all which can be measured and to make things measurable which cannot already be measured".

Very often a part of uncertainty is included in information. In most of these cases it is caused by a lingual uncertainty which we all already found have in our life. E.g. we say that a management of a company is "experienced", "already experienced" or "not experienced". This is a typical example of basis information of some rating systems which are used in banks.

The mathematical description of such information – using exact real numbers – is not possible. Even "obvious exact" information is in fact fuzzy if we have a closer look on it.

Types of uncertainty or fuzziness which is included (very often hidden) in information are

- Randomness
- Errors of measurements
- Uncertainty in used models

Of course this uncertainty or fuzziness can be caused by combinations of the types which are listed above.

It is within the "nature of a complex system" that some information is "fuzzy". So it is very important to be able to describe it in mathematical models in order to be able to describe complex systems.

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2. Description of fuzzy numbers

If we try to analyze information or observations we always use numbers. As mentioned before most of the available information or observations are not exact but fuzzy. Based on the idea of Karl Menger (1902-1985) a set can be characterized by an indicator function. So if we have a set **A** which is subset of **M** the indicator function is defined by:

$$I_A : M \to \{0,1\},\ A \subset M$$

$$I_A(x) = \begin{cases} 1 & \text{for } x \in A \\ 0 & \text{for } x \notin A \end{cases} \qquad \forall\, x \in M$$

1951 Menger published his idea of fuzzy sets. Now we have to consider how fuzzy numbers can be described.

Definition 1:

A fuzzy subset A^* of a set M is described by a so called membership function $\mu_{A^*}(.)$ which is:

$$\mu_{A^*} : M \to [0,1].$$

A fuzzy set A^* is called normalised if:

$$\exists\, x \in M : \mu_{A^*}(x) = 1.$$

Similar to this we can describe a fuzzy number x^* by a characterizing function.

Definition 2:

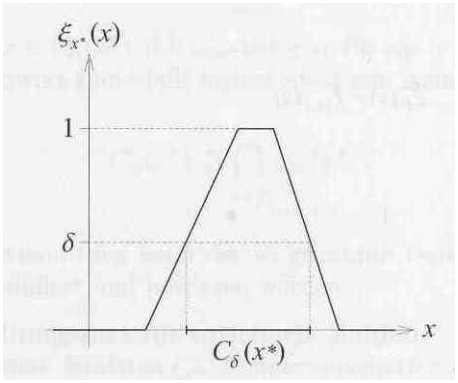
A real function $\xi_{x^*}(.)$ is called a characterizing function of a fuzzy number x^*, if following conditions are fulfilled:

(1) $\xi_{x^*} : R \to [0,1]$

(2) $\forall\, \delta \in (0,1]$ the δ-cut $C_\delta(x^*) := \{x \in R : \xi_{x^*}(x) \geq \delta\}$ is a finite, non-empty and closed interval. So $C_\delta(x^*)$ is always a compact interval.

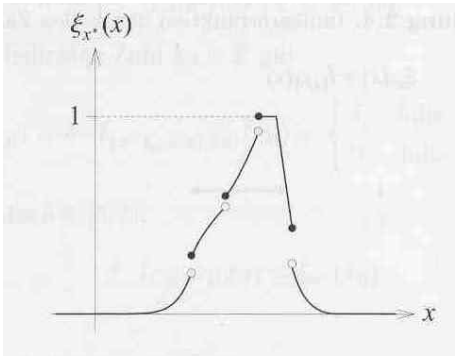
Examples for characterizing functions are represented in the figure following

- Characterizing function is a trapezoid

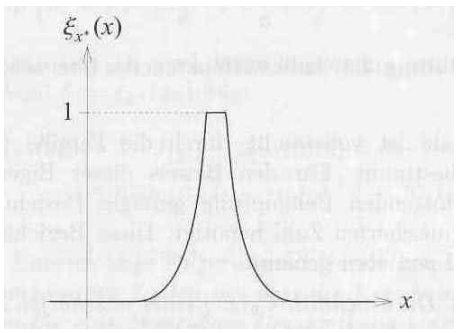


This figure shows a δ-Cut $C_\delta(x^*)$ also.

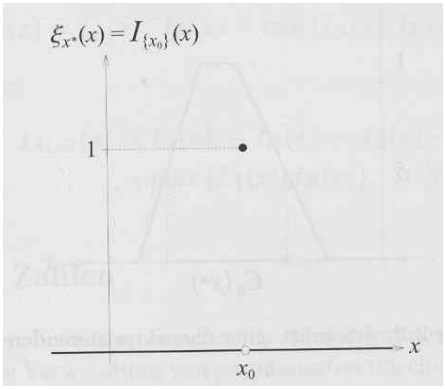
- A non-continuous characterizing function



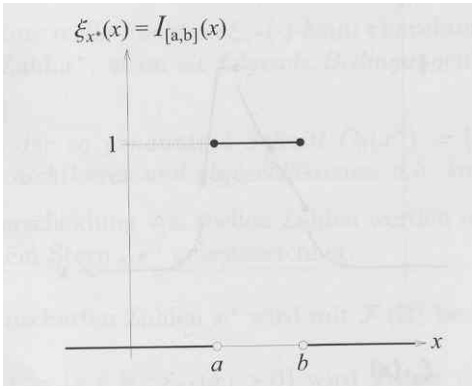
- A continuous characterizing function



- An indicator function which describes a real number



- An indicator function for the interval $[a, b]$ with $a, b \in R$



If there is *n*-dimensional information we describe it by fuzzy vectors. Fuzzy vectors are described by vector characterizing functions.

Definition 3:

A function $\xi_{x^*}(.,...,.)$ of *n* real variables is called a vector-characterizing function of a *n*-dimensional fuzzy vector x^* if following conditions are fulfilled:

(1) $\xi_{x^*} : R^n \to [0,1]$

(2) $\forall\, \delta \in (0,1]$ the δ-cut $C_\delta(x^*) := \{x \in R^n : \xi_{x^*}(x) \geq \delta\}$ is a imply connected and compact subset of R^n.

Even very interesting is to consider functions of fuzzy numbers. For this we do the following definition.

Definition 4:

The supremum of a function $f: R^n \to R^k$ over an empty set $\varnothing \subseteq R^n$ is defined as zero:

$$\sup\{f(x): x \in \varnothing\} := 0$$

If we have to do some statistical methods of observations which are fuzzy we have to do it very often on functions of these observations. So we have to consider an enhancement of real functions even to be able to operate with functions of fuzzy numbers.

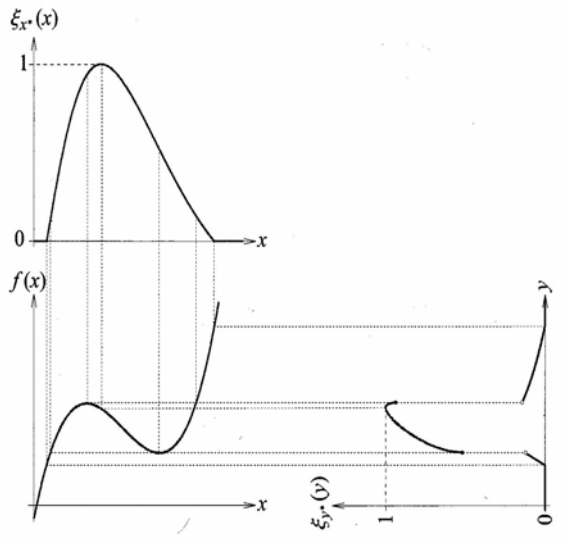
Principle of enhancement:

For a real function $f: R^n \to R^k$ the characterizing function $\xi_{y^*}(.,...,.)$ of a fuzzy vector $y^* = f(x^*)$ is defined by:

$$\xi_{y^*}(y) := \begin{cases} \sup\{\xi_{x^*}(x): f(x) = y\} & \text{if } \exists\, x \in R^n: \ f(x) = y \\ 0 & \text{if } \neg\, \exists\, x \in R^n: \ f(x) = y \end{cases}$$

for all $y \in R^k$ and assumed that $\xi_{x^*}(.,...,.)$ is the characterizing function of x^*.

In the following picture an application of this principle is shown.



3. Mathematical operations on fuzzy numbers

Now we have to consider how operations on fuzzy numbers have to be defined. Each result of such an operation is a fuzzy number. So it is

obvious that even the result of an operation on fuzzy number is identified by a characterizing function.

So the fuzzy operation $x^* = x_1^* \oplus x_2^*$ can be seen as function $f(x_1, x_2) = x_1 + x_2$. According to the "principle of enhancement" the characterizing function of the sum of two fuzzy numbers can be calculated as:

$$\xi_{x^*}(x) = \xi_{x_1^* \oplus x_2^*}(x) = \sup\{\min(\xi_{x_1^*}(x), \xi_{x_2^*}(x)) : (x_1, x_2) \in R^2 \text{ and } x_1 + x_2 = x\}$$

$$= \sup\{\min(\xi_{x_1^*}(y), \xi_{x_2^*}(x - y)) : y \in R\}.$$

For the multiplication of fuzzy numbers $x^* = x_1^* \otimes x_2^*$ which is like $f(x_1, x_2) = x_1 \cdot x_2$ the product of two fuzzy numbers is given by:

$$\xi_{x^*}(x) = \xi_{x_1^* \otimes x_2^*}(x) = \sup\{\min(\xi_{x_1^*}(x), \xi_{x_2^*}(x)) : (x_1, x_2) \in R^2 \text{ and } x_1 \cdot x_2 = x\}.$$

A special case is $y^* = \lambda \otimes x^*$. Here the characterizing function is:

$$\xi_{y^*}(y) = \xi_{\lambda \otimes y^*}(y) = \sup\{\xi_{x^*}(x) : x \in R \text{ and } \lambda \cdot x = y\}$$

$$= \begin{cases} \xi_{x^*}(\lambda^{-1} \cdot y^*) & \text{if } \lambda \neq 0 \\ I_{\{0\}}(y) & \text{if } \lambda = 0 \end{cases}.$$

If we now consider the MIN-function of a fuzzy number we have to define it by using δ-cuts of the characterizing function of this fuzzy number. So if $C_{i,\delta}$ is the δ-cut of x_i^* with:

$$C_{i,\delta} = [a_{i,\delta}, b_{i,\delta}], \quad \delta \in (0,1], \quad i = 1,...,n$$

the δ-cuts of $\min[x_1^*,...,x_n^*]$ are defined as:

$$C_\delta = \left[\min_{i=1,...,n} a_{i,\delta}, \min_{i=1,...,n} b_{i,\delta} \right] \qquad \forall\, \delta \in (0,1].$$

The characterizing function $\xi(.)$ of the fuzzy $\min[x_1^*,...,x_n^*]$ is given by:

$$\xi(x) = \max_{\delta \in (0,1]} \delta \cdot I_{C_\delta}(x) \qquad \forall x \in R.$$

In the same way we get the MAX-function. The δ-cut of the fuzzy MAX-function is defined as:

$$C_\delta = \left[\max_{i=1,...,n} a_{i,\delta}, \max_{i=1,...,n} b_{i,\delta} \right] \qquad \forall \delta \in (0,1].$$

The characterizing function $\xi(.)$ of the fuzzy $\max[x_1^*,...,x_n^*]$ is given by:

$$\xi(x) = \max_{\delta \in (0,1]} \delta \cdot I_{C_\delta}(x) \qquad \forall x \in R.$$

4. Statistical Analysis of fuzzy information

If we now try to describe fuzzy observation in a statistical way, we will get for the:

– *upper limit of the fuzzy relative frequency*

$$\bar{h}_{n,\delta}(K_i) = \frac{\#\{x_j^* : C_\delta(x_j^*) \cap K_i \neq \varnothing\}}{n}$$

– *lower limit of the fuzzy relative frequency*

$$\underline{h}_{n,\delta}(K_i) = \frac{\#\{x_j^* : C_\delta(x_j^*) \subseteq K_i\}}{n}$$

where:

#... is the number of elements in the set

and:

K_i… are disjunctive classes.

The δ-cut of the *fuzzy relative frequency* $h_n^*(K_i)$ can be calculated as follows:

$$C_\delta(h_n^*(K_i)) = [\underline{h}_{n,\delta}(K_i), \bar{h}_{n,\delta}(K_i)].$$

The *empirical distribution function* of fuzzy observations is defined by:

$$\hat{F}_n^*(x) = \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{\int_{-\infty}^{x} \xi_{x_i^*}(t)\mathrm{d}t}{\int_{-\infty}^{\infty} \xi_{x_i^*}(t)\mathrm{d}t} \qquad \forall x \in R$$

where:

$x_1^*, ..., x_n^*$ are fuzzy observations

and:

$\xi_{x_1^*}(.), ..., \xi_{x_n^*}(.)$ are the characterizing functions of the fuzzy observations

and

we assume that:

$$\int_{-\infty}^{\infty} \xi_{x_i^*}(t)\mathrm{d}t \neq 0 \qquad \text{for } i = 1, ..., n\,.$$

If we have a mixture of normal and fuzzy observations we get:

$$\hat{F}_n^*(x) = \frac{1}{n} \cdot \sum_{i=1}^{k} I_{(-\infty, x]}(y_i) + \frac{1}{n} \cdot \sum_{i=1}^{l} \frac{\int_{-\infty}^{x} \xi_{x_i^*}(t)\mathrm{d}t}{\int_{-\infty}^{\infty} \xi_{x_i^*}(t)\mathrm{d}t} \qquad \forall\ x \in R$$

where:

$y_1, ..., y_k$ are normal observations

and

$x_1^*, ..., x_l^*$ are fuzzy observations

and

$k + l = n$ observations in our sample

and

$\xi_{x_1^*}(.), ..., \xi_{x_l^*}(.)$ are the characterizing functions of the fuzzy observations

and

we assume that:

$$\int_{-\infty}^{\infty} \xi_{x_i^*}(t)\mathrm{d}t \neq 0 \qquad \text{for } i = 1, ..., 1\,.$$

Examples:

The following examples show that fuzzy observations are in almost every topic where we believe that observations are exact.

Impossibility of exact data definition

The loss caused by black economy cannot be estimated to due non available information. Even the definition of "black economy" is a very fuzzy one.

Different information

Different vendors of the same product will sell with different prices. So we cannot answer the question of THE PRICE of a product. THE PRICE of a product can be described by the min and max value which we already know.

Limited precision of analyzers

All analyzers which are used to measure continuous values have a very limited scale and even limited precision. Digital analyzers have a finite number of decimal digits on their displays.

Missing objective scale

The value of a building or a valuable is influenced by attributes of the person who gives estimation for this. Even if we evaluate the quality of a management we are influenced by our own opinion.

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THE NEUROMARKETING – AN INSTRUMENT OF THE TRADITIONAL MARKETING TECHNIQUES

Cristina BURGHELEA[*]

Abstract: *The human emotion characterized from a commercial point of view is perceived as a limitative message whose focus is the product. The tri-dimension of the emotion meets the message which determines the spread of the information and need to consume and acquire. So, the emotional essence of the one who decides the consuming determines a pressure which is reflected in the promoting of the product. The need to use a product determines the interfingering between the two sciences neurology and marketing and thus resulting the neuromarketing. The neuromarketing appeared from the need to sustain a decision by all possible means when its pressure is a way over the ability of a decision maker to confront failure. The advertising messages will no longer regard the reason or emotional side of the consumer which leaves room to "escape", but will regard directly the process is of the brain, onto which most of the times, the human being has no control over, but can simulate a credibility of a message received and can interpret in the same time those erosions which "bother".*

Keywords: *product; consumer; advertising; promotion; neuromarketing.*

1. Introduction

The traditional marketing starts from an innovating idea but in the same time with the traditionalist predominance: that every product can be launched on the market even the need to acquire that product is not the marginally determined. They refer to the marginal need through the fact that the consumer must be determined by a superior or inferior limit of the acquiring thinking of not only an innovative product but also a useful one. The need to use the products is not determined by a soul individual but by a collectivity of individuals who can influence the desire to acquire of each other but also the assimilation of the idea "to have".

Traditional marketing started from the paradigm death through adequate promoting activities any products can be launched on the market regardless if the consumers need it or not, regardless if the products is

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viable or not. The result is that even at present about 95% of the new launch products have a life expectancy of a maximum of six months even if they had an advertising campaign to impose them as an image and as an idea of the existence of what will eventually be thought as an "absolute product". That is why the paradigm has been changed and modern marketing considers that only the identification and satisfying the needs and desires of clients is the way towards success; sex acts which actually shows a superior limit that the necessity vector can reach but also an inferior one up until which the shadow of failure leads to unsatisfying the desires of the client.

Only that this new paradigm is difficult to transpose into practice because up until now the information linked with the desires and needs, the evaluation criteria and the decision-making strategy have been collected through techniques subjected to great errors.[1] Approximately 95% of the process is leading to the satisfying of consumers are developed at an unconscious level, while the traditional investigation methods (focus groups, interviews etc.) are concentrated on the conscious, reasonable elements of perceiving and elaborating the reaction to them. This way information alteration is introduced, of which psychology and sociology are aware, but not those who pay the actual studies.

The conscience perception of the products is determined by the necessity but also by the need of novelty, which acts like an inhibitor but is in fact the information which can be altered, and the vows becoming only a tangent with the aware element generating unhappiness at an informational reception level.

For example, in focus groups the opinion of a group appears, and the opinions are polarized around two positions (for example for and against a product), most of the people tending to accept without a critical analysis the opinion expressed by the person with the most resonance.

Creating the interface of a product to manipulate a mass of people is very easy to accomplish because the starting point is "the unconscious" which can be maneuvered so as its own opinion to complete and even identify itself with the opinion of the others.

Another phenomenon is the predisposition to risk, the opinion of the group becoming more radical than that of the people taken separately, because a sum of opinions forms a whole and represents a force while the individual opinion doesn't have the orientation nor the characteristic a mass opinion has.

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[1] Chief Executive September 2006, No. 9, Daniel Bichis, *The key to the Consumer's Mind*, page 39

In addition there is a tendency to identify with a social image which makes the participants respond according to what they think the interviewer would like to hear. That is why a change of the communicational roads between the products and the client is imposed, and even creating new ideas which generate solutions.

The quantum of solutions leads to the appearance of "salvaging ideas", which can be enounced like so: in order to make the products be bought it is necessary to create them according to the unconscious needs and desires of consumers, and during the whole promoting, buying and using processes nice emotional experiences to be created for the customers. The experiences had at an emotional level are those obtained by each consumer through identifying, observing but in the same time through a great influencing of the subconscious we does specifically determines need to acquire the unique quality in acquiring products. The emotional phenolmenon is more and more emphasized, but also it is more and more manipulated by an overwhelming majority of those promoting based first of all on the characteristics of the superior a limit of human emotion, emotion created on certain stimuli which can lead to the appearance of chain reactions.

This means transferring the emphasize from traditional to modern elements, from reasonable to emotional ones, from conscious to unconscious ones – this being possible only by applying the neuromarketing.

2. The neuromarketing phenomen

The neuroscience exists for many years. Often it has been misunderstood and sometimes even mistaken with some practices. Its principles are tested in business through its abilities to influence the decision of consumers, decision which can be influenced anyway more or less by external or internal factors present at the level of each human activity.

The appearance of this technique started many controversies. The skeptics think that this is a way to manipulate consumers, while others think that neurosciences are fascinating.

Invented at Harvard in the mid '90s by Professor Gerry Zaltman the neuromarketing is a combination between two sciences, neurology and marketing, through which the instruments used by the first one initially only for medical interest, are now being used in advertising purposes. The neuromarketing appeals to the technology of transmitting images through magnetic resonance – MRI, technology used to detect brain tumors, but which allows reading the way the brain receives, processes and interprets various images presented to it.

The term neuromarketing designates using the identification techniques of the brain mechanisms to understand the consumers' behavior, in order to optimize the marketing strategies. Answers at the eyes' (in ECT) or the brain's level (especially through EEG and fMRI) are being monitored to determine the way the consumer perceives, evaluates and reacts to the stimulant represented by an advertising message, a product or a service.

This way one can find out how the human brain responds to a very advertising message, and marketing personnel can their facts their options to popularize a brand. The impact of the message on the brain represents in fact the key to open a Pandora's Box. The accomplishment of this mechanism can lead to increasing sales and most of all to creating a new perspective and orientation at a sales developing level. This can be done with the help of some consumers' representatives who will be presented some images while they are introduced in a machine and subjected to some radio magnetic fluxes.

The fragmentation of mass communication can become a force which added can create an overwhelming impact and can determine just the same fragmentation of the way consumers react. Implicitly, great corporations look for means as precise as possible to target the advertising message.

Advertising is not lights in the old days – you take a products and state is the best on the market and then determine the individuals by different means to acquire it. Now you must know your target audience, carefully studying his behavior, but most of all interact with the necessities of the client, determining him to "choose" you. But the way can now best the consumer, that people whom a product or service addresses to, is that of going straight to the source, more accurate... to the brain. That's the way one can find out in a relatively short time the behavior of the buyers, their desire to acquire unique products, and the advertising campaign can be changed on the way to have a more certain and overwhelming impact on those who determine the survival on the market.

The desire for affirmation but also the need significantly determined to conquer a certain target audience, led to the appearance of strategies and the advertising companies' level which have started to invest massively in brain studies, studies which have led without intention to the innovating concept of neuromarketing.

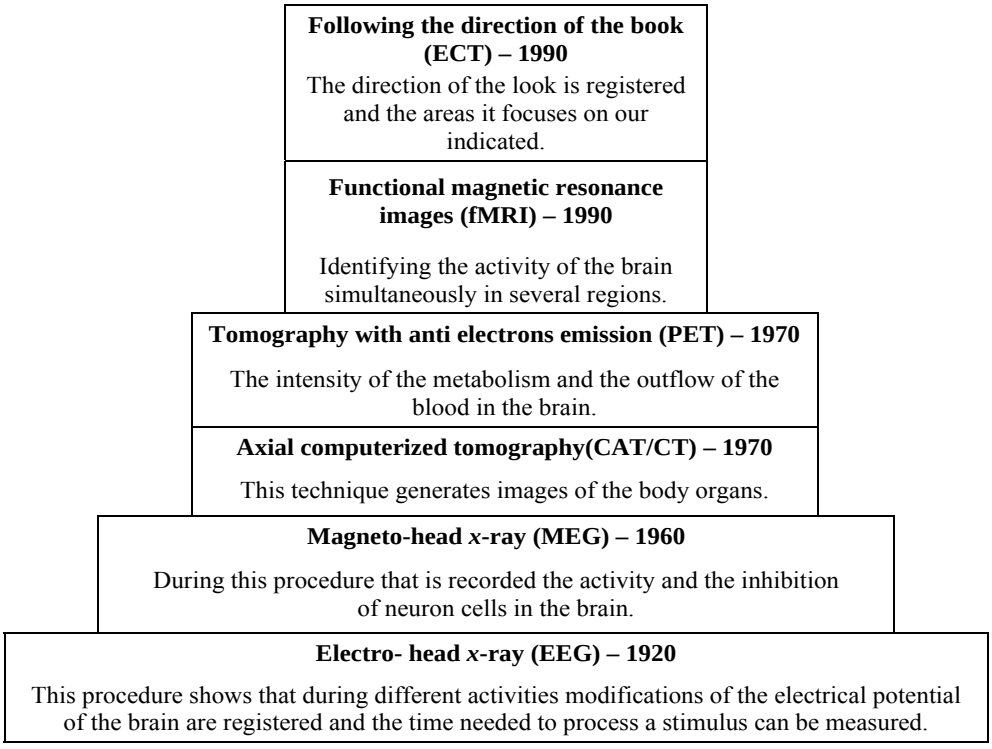
The neuromarketing tries to find new breaches on the market, tries to understand and obviously to influence the consumer, tries to develop managerial strategies which can influence the great mass of those who significantly determined can reduce the major impact of the losses at an emotional level. Those who try to find interdependency between the consumer and his emotional development are based now on many recently

developed procedures: imaging with magnetic resonance, from which result all kinds of images with brain reactions to different stimuli.

In the figure presented below are presented the main techniques used in neuromarketing which follow either the activity in the profound structures of the brain (fMRI and PET), or in the surface ones (EEG and MEG). These techniques can resemble open windows to the interior of the brain, which allow registering to modification of its functioning during the interaction of the consumer with the tested product. The obtained information allow choosing even more efficiently the need for a product, the type of advertising message, the form it is transmitted in, the conceited to elements of the products or packaging, the delimitation of the price categories used etc.

For now some methods are less accessible, taking into account costs but also of obligating the subjects to find themselves in an environment very different from the usual one, environment which can lead to the detaching of an emotional collapse and the failure of the used technique (especially PET and fRMI).

That is why they will probably be used especially for the fundament of some studies, to detect some stimuli, based on which the obtained results can be interpreted better, for example, by associating the EEG with the ECT.



The need to be sold and the need to be known makes each products try to interact with the consumer. The product is the one who opens the window towards the inside of the human brain with the help of the need but also the desire to acquire it. There, at a neuronal level one can observe a modification of the functional activity during the interaction between the consumer and different types of products. Choosing these techniques only enhances the efficiency of the sales and the actual message becomes a collective hypnosis. The actual connectivity is the one who should have been effectively determined and stimulated to acquire but also to choose more or less strategic pivot products. Up until now the marketing solutions were limited to interact methods of reading our thoughts and feelings. These noticed how and how much we bought according to the increase or decrease of prices. An absolutely necessary pivot in marketing development in general is poll approach. But they aren't always exact; first of all, because the people don't always say what they think or do. That is why traditional researches are much more intuitive and lack perspective. Then the fidelity cards were invented. But not even this method could attain a complete and relevant image, Because not every consumer accepts to be in a database in exchange for some very low discounts.

Even from the first appearances on the market of the neuromarketing concept one could observe that the consumer identified himself with the image of the products and he was more and more tented to say that the product is exactly like him. The studies performed show that the engine of the commerce is represented actually by the conclusions reached in the interactions between neurology and marketing, meaning the association between the self image and the individual knowledge of each of us.

"Even from the first attempts of Professor Gerry Zeltman from Harvard University performed in the '90s, the neuromarketing attracted the attention of the great companies and found itself a lot of applications. Following the model first met in genetic engineering and pharmaceutical research there is a very close collaboration between the great investors and university laboratories involved in this kind of research."[2] Here are some of the main developing fields:

3. The competitive advantage of using neuromarketing

The marketing world has always searched for an answer to that question: to what degree the quality of the product, even recognized by the consumers, represents a source of competitive advantage. The most

[2] Chief Executive September 2006, No. 9, Daniel Bichis, *The key to the Consumer's Mind*, page 40

authentic example was offered by the competition between Coca-Cola and Pepsi Cola. In order to delimitate very well its target market but also to increase his market share, Pepsi launched in the '70s the campaign called The Pepsi Challenge following which a series of tests were performed in supermarkets and mini markets where the consumers were asked to decide which of the two beverages was tastier. Without knowing what beverages it was about, but most of all focusing on quality 57% of the participants chose Pepsi and only 43% chose Coca-Cola. These results were intensely exploitted from an advertising point of view and to prepare the sales force, but the effect regarding the increase of the market share was insignificant.

Later on an experiment was performed through which the activity of different areas of the brain was measured with the help of the fMRI when the subjects came into contact with the two products. The obtained results were pretty relevant and brought one more time on the first plane the idea that the existence of neuromarketing and the company's motivation to develop their activity in this sense:

- When they didn't know what beverages it was about, 75% of the subjects preferred Pepsi, the beverage which activated stronger the area of the brain which corresponds to the sensation of satisfaction, of sensorial pleasure;
- When they knew what beverages they tasted, the report was reversed and for 75% of the people tested Coca-Cola determined the activity of the area of the brain which responds for valuable judgments and reason and the one containing the emotional memory.

The experiment shows that the brand image produces the arousing of some emotions which can become stronger than the direct effect of that product. It is a demonstration of the reality of the statement that "the products are created in the factory and the brand is created in the mind of the consumer and is the one who gives the power and the motivation to success".

For 30 years the obstinacy with which the consumers continued to buy a products they now is less tastier than that of the direct competitor was an enigma, explained through a mysterious "branding effect" which couldn't be decomposed in elements to be repeated what could be analyzed and may be rethought as a future strategy.

The neuromarketing is a revolutionary concept which boomed in the United States and which recently became known in Europe. A recent study for formed at Daimler Chrysler showed that the "reward centers" in men's brains were activated by sports cars in the same way the response to alcohol or drugs.

If a study were performed in our country based on the messages in election campaigns one would notice the fact that in most cases "the brain"

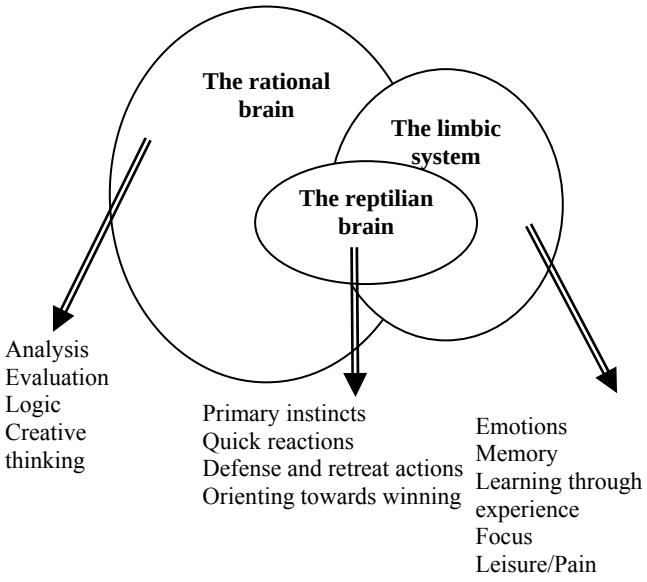
of the people masses responds differently, and the image about each candidate is perceived as a whole which is individualized in individual accomplishment.

The image is formed in the mind of the information consumer and is developed in the superior limit of the desire to succeed by voting the best candidate and thus creating, at a certain time, more or less, a mass hypnosis.

4. Maximizing the impact of advertising

Researchers have proposed a model of the human brain constructed out of three super posed structures; each of them specialized on certain functions:

- The R complex (reptilian) or the primitive brain, controls the body and decides very rapidly the strategy we use (we act, we retreat or we wait), to ensure the satisfying of fundamental needs (physiological, sexual, security and territory defense etc.);
- The limbic system for the emotional brain, associated with emotions, feelings attention, general attitude, usual memory (the recalling of events), the immunity and hormonal balance, the relationships with the others; its decisions refer to the pleasure or non pleasure we associate with that situation;
- The neo-cortex or the rational brain, which analyzes and solves the problems, uses the language and logic, constructs rational memories (of the materials studied for an exam type) and leads the creative thinking; its decisions refer to sticking to the rules and previous experiences, convictions and personal values, self image.



In short one can say that in the face of a product the rational brain evaluates, the emotional one senses, and the primitive one decides what we have to do. We are aware only of the results of the reasonable evaluation and partially on the effect on the emotional state. If nor the basic reactions or emotions are involved the advertising message is simply ignored. That is why, in order to have an effect, advertising is addressed first of all to the emotional and primitive brains which it has to determine to open the channel of focus which transmits the information the words the rational brain too.

The automobile company Daimler Chrysler financed an experiment which wanted to establish the types of automobile men want. The result itself was not expected, preferences being for about 2/3 of sports automobiles, about 25% of limousines and the rest for compact class.

The important fact was that in this test it was shown that sports automobiles activate strongly an area of the primitive brain initially considered as being involved in making decisions linked to vital elements (appetizing food, attractive and available sexual partner). Activating that area usually leads to blind gestures, the man acting instinctively to obtain that trophy. Also the neuronal rewards circuits are activated which thus produce a profound emotional state, the rational brain is preconditioned to supply justifications and solutions to obtain that product. There's nothing new, off a mobile dealers will say, as they know very well the affect the presence of a beautiful lady by the side of the car she offers has. But this finding allowed redrawing the bodies of the limousines and of the compact class so was to determine on their own a very motivated answer. And it lead to the re-conceiving of advertising messages and of the presentations of the sales agents followed by an increase of sales up to 40%.

Another study demonstrated that the act of buying by a person can even be "predicted" observing with the help of imaging through magnetic resonance the activation of neuronal circuits. The great companies are so interested in these evolutions of science that they act many times in a coalition. But in the same time, the collaborations with the laboratories of cognitive sciences are done with maximum discretion, out of the fear of arousing by accident negative reactions of the public opinion.

In our country a special impact which can be the basis for the presence of neuromarketing was the advertising campaign Maggi developed in 2005. It had a special resonance by "optimizing" the memorizing of an advertising campaign according to the repeating of the messages and their diffusion in many environments of mass communication. The idea was so successful, and the transmitted message had such a special resonance and the target public level that the mother company Nestle Rumania decided to

renew the Maggi campaign in 2006 with the slogan "The Maggi heart comes back home twice as precious!"

Transmitting information repeatedly through these innovative "ideas" to persuade the consumers to make the ad in the benefit of the firm with a low cost, represented by the value of the awards given following the campaign represents an absolute success of the presence of neuromarketing on the Romanian market. So, the message seen by the consumer where ever he was determined the motivation to buy and the resonance of the success made the neuronal circuits activates the stimulating centers of necessity.

The stimulated envy by the potential winnings determined the motivation at a neuron-psychical level of the population, so 85%[3] Of the Serbian population one it to receive the promotional Maggi flyer, a percentage never reached by another developing campaign until present. The frenzy of this campaign brought out the imagination of the individual to find as visible as possible places to promote Maggi hearts. The general desire for a possible daily 2000 euros earning stimulated the subconscious of the consumer thus generating a passing state of happiness which could only be satisfied through that visible competing to acquire as many Maggi hearts as possible which covered without much effort a significant part of the "urban windows". The success of the campaign was overwhelming because the stimuli of the mass hypnosis were detached and all that one called product individualization became a initiating factor of the need "to have".

But studies were performed over the Internet to and it was proven that the accuracy of the anticipation of the buyer behavior is of 77%. The exact purpose in this case was setting the way a certain site had to be constructed and what kind of contents it should've had. With the help of biometrics sensors have been recorded all the reactions of those analyzing a certain site: the conductivity of the skin, the pulse, the respiration, the mimic and gestures.

The lack of free time and the human need quickly led to conceiving the sites for virtual stores. The consumer analyses following a documentation and decides what to acquire. The visual impact tangent with the desire to acquire is the initiating stimuli of virtual madness.

On the Internet technology has evolved very quickly, the need to know the behavior of the customer led to the apparition of "pop-up ads" – advertising windows which appear when visiting a certain site. It has gone so far that the advertisers wanted to know which area of the screen we look at more often, as well as the area we access most often with clicks.

The financial force of these businesses attracted very many hackers which have developed special viruses: adware and spyware. These viruses

[3] http://adplayers.ro/articol/-11/Maggi-pump-twice-as-much-557.html

are in fact programs which correlated to the information obtained through Pop-ups, which download automatically promotional materials posted in the already learned areas through ”screen knowing”.

The chaotic receiving of spam messages leads to the initiation of the desire to acquire especially by stimulating the desire to try out a product you receive a lot of emails about. The advertisers are based on the mass effect, by sending as many spam’s as possible to which very few will answer.

Seeing the message initiates at a neuronal level a simulation of the desire to acquire and thus no a subtle manipulation of the consumer it is strides actually to consciously limit his memory.

In a very close future the accident factor on the Internet will be forgotten and the contents will go to the users already “analyzed” by the consumers and then adapted for them.

For the specialists in neuromarketing the self image and the self knowing of each of us represent the white gold of a perfect alchemy: the transformation of the self love in the low of four the other self which is transposed in an advertising target. The consumer must tremble, vibrates and feel an overwhelming desire to acquire a product; the comfort of having a relative stability and being dominated by the continuum desire to acquire. The subconscious memorizing mechanisms are those who initiate the actions leading to the evaluation of the state of satisfaction of the masses.

”The intimate knowledge of the consumer’s brain can only incite the enterprises and their advertising deputies to escape from the spaces normally allocated for communications. The conditions of the receptivity of a brand are judged more favorably as the “target” is not actually aware it is regarded. It is what the rapid development of the advertisement explains, this hybrid between advertising and amusement”.[4]

5. Motivation through advertisements

The traditional evaluation methods of the efficiency of advertisements (re-memorizing the spot, recognition tests and measuring the attitude towards the product or brand) is based exclusively on what the subjects report – so it is limited to the conscious memory. The purpose of the advertising investment is to determine people to buy their own promoted products or services, not to understand their advantages or to like the story of the spot. The essential difference between emotion and reason is the fact that emotions make us act, while reason only makes us evaluate. And when

[4] Le monde diplomatique, Marie Benilde, *Advertising Is Involmed in Neurosciences,* November 2007, pag. 3

we talk about motivation, we almost exclusively refer to the emotional and the reptilian brains.

The advertising message with an intensively emotional content activates imagination, people having the tendency to verify in what way the product can satisfy them. The result is that after such an imaginative test the information is memorized as if the experience would have actually occurred and activates decisional elements in the primitive brain. There are some clear differences between the answer of the brain towards the reasonable and emotional spots. The latter activate strongly the areas of the brain implicated in establishing social relationships and making decisions – exactly the type of answer any company which invests in TV advertising wants. Using the neurosciences represents the most important progress in the field of market research in the last 25 years.

For the moment a translation of the neurological data in the specific marketing language is being done, so as for the information to be used by those who know the other elements of the marketing mix.

6. Conclusions

The neuromarketing offers a multitude of additional information, but it can't offer any kind of information linked to the behavior of consumers. The second limit is that of the price and technology. For the moment, the PET and fMRI (the strongest) type techniques can only be applied in the laboratory, and the rental price of the equipment is significant. But it can be estimated, like has happened with a lot other technologies that the appearance of real demand for such equipment for other purposes than medical ones will lead to a rapid decrease of the cost and dimensions of the equipment.

At last, it mustn't be ignored the reaction of consumers' associations which fight for the limiting of the freedom of advertising agents and market studying companies to obtain information about the way the consumers elaborate their decisions. It is a reaction determined by fear of the possible latter manipulation by identifying an "acquisition button" to transform them into certain victims of the advertising messages. One can observe that: even a reduced increase of the efficiency of advertising leads to a boom of some diseases such as: obesity, anorexia or type 2 diabetes.

But such reactions fueled by the hunger for sensational of the media are not justified.

What neuromarketing can actually do is improve the way the companies create and promote products so as to make them more interesting,

attractive and valuable for the consumers. The objective of neuromarketing is to change the behavior of companies which can easily pass over the decision of the individual and not over the behavior of the consumers.

At least this is what the promoters of neuromarketing sustain, the market studying technique which appeals to psychiatric instruments to guarantee the advertising message will permanently and efficiently stay in the mind of the audience.

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NEW ECONOMY Section

SCIENTIFIC KNOWLEDGE IN THE COMPLEXITY OF THE NEW ECONOMY

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Abstract. *The paper "Scientific Knowledge in the Complexity of the New Economy" aims to emphasize the importance of rationally using the scientific knowledge in the new economy, only for the purpose of creating social welfare and ensuring competitiveness for each individual upon the highest level. The ground is represented by the idea that mankind today has undergone a series of critical phases during its existence, and that nowadays we are facing the beginning of the Responsibility Century. Man is becoming the central pillar for decisions made at any level, as it is regarded as the main resource of the current society. This paper considers enunciating the following objectives: defining the concepts of making individuals responsible, real values of the "whole common living", enterprises' "corporate social responsibility", "information" and "knowledge" in view of the transfer from the old to the new economy, as well as implementing the methods for increasing the level in individual's awareness, protecting the real values of the "whole common living", discovering the essence of responsibility taking into account the specific aspects of the new economy.*

Keywords: *new economy, making individuals responsible, knowledge, economic growth.*

1. A new phase for mankind – the beginning of the Responsibility Century

Given the current context faced by mankind, it can be asserted that humanity undergoes a new phase, of profound connotations and implications on a general level, namely the beginning of the Responsibility Century.

The core objective of the "2000 Lisbon Strategy" implies that in view of year 2010 the European Union will become the most competitive and dynamic knowledge based economy worldwide, able of sustainable economic growth, with the best jobs and the largest social cohesion[1].

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[1] Presidency Conclusions Lisbon European Council, 23 and 29 March 2000, paragraph 5, www.europact.eu.int/summits/previous.htm

Given this vision, the themes approached by the "2000 Lisbon Strategy" open a series of extremely important issues for the European Union.

The "2000 Lisbon Strategy" also provided a provision of particular theoretical and practical value "*The European Union is confronted with a quantum shift resulting from globalization and the challenges of a new knowledge-driven economy. These changes are affecting every aspect of people's lives and require a radical transformation of the European economy. The Union must shape these changes in a manner consistent with its values and concepts of society and also with a view to the forthcoming enlargement*[2]". This processes' shaping, grounded on the values promoted by the European Union is expressed by the social model of the entire policy "*People are Europe's main asset and should be the focal point of the Union's policies. Investing in people and developing an active and dynamic welfare state will be crucial both to Europe's place in the knowledge economy and for ensuring that the emergence of this new economy does not compound the existing social problems of unemployment, social exclusion and poverty*[3]".

From the information above there can be noticed that man becomes the central pillar of decisions made at any level, and that it is considered as the main resource of the current society. Under such circumstances, **the individuals' responsibility level should increase**. However, the process of making individuals more responsible should begin from **inside**, and not in response to external factors.

People hold the "cosmic-technical" energy, and hence the power of destruction increases. That is why people should be responsible for their actions and they should use the knowledge they currently have only for the interest of mankind and in order to protect the real value of the "whole common living". It is of common knowledge the fact that throughout history mankind has faced various phases marked by a series of disasters produced consequent to using knowledge for destructive purposes. In this respect, there can be mentioned the creation of atomic bomb, with devastating effects that can be noticed even nowadays, the gradual destruction of the ozone layer, with severe consequences over weather worldwide, generating major disequilibrium, genetic modification implemented on plants, animals and even humans, able to generate results that are only now beginning to take shape and which will definitely become visible in the near future.

[2] Presidency Conclusions. Lisbon European Council, paragraph 1
[3] Presidency Conclusions. Lisbon European Council, paragraph 24

Another challenge of the new economy refers to the value of attempting to favor the increasing of knowledge background of different nations. For such purpose, promoting economies opening seems to represent an advantage, especially if it can ease learning by observation. Regarding the main issue of the new development, the efficient use of resources and the focus on the role played by positive externalities in the economic growth process, Professor Constantin Popescu (Popescu, C., 2002) underlined the following aspect: "*The increase in the production of economic goods can support development and achieve individual and social human welfare, upon the condition of keeping the ecological equilibrium, or it can occur by polarizing the economic life upon directions that increase real costs for the selected alternatives. The last mentioned economic growth, which wastes the limited resources, is a growth generating poverty*".

Mankind's global and local ecological issue cannot be solved unless for knowledge society and important elements of the new economy will be also imposed by ecological and not only informational considerate.

a) The Responsibility Century refers to creating an ecologically sustainable society, because unless for scientific knowledge, technologic knowledge and management of such, no assets, organizations, and technological, biological and economic transformations would be produced which are necessary for the **sense evolution** pursued by mankind.

b) The Responsibility Century is global and it involves all elements of the common living whole. Knowledge society, by both its components, informational and sustainable, will be of global nature.

c) The Responsibility Century will also represent a new phase in the culture, the first plan being occupied by knowledge culture in view of responsibility, which involves all knowledge forms.

1.1. The concept of individuals' "social responsibility" – discovering the essence of responsibility in the relation between "people" and the "living whole"

Knowledge should be used in order to change people from inwards and such should not be grounded that an external change over humans, in the attempt of making them more responsible, could have long term surprising and positive effects. The focus should be on human values, on the implementation of modalities for making individuals responsible, which could lead to long term results, and this becomes possible as soon as every particular individual becomes entirely aware of his/her contribution to mankind.

The current society places as focal point the **consumers' demand and needs**, involving to an ever larger extent the design, production and

use of goods and services from their very research and development. From this standpoint, the new economy is of interactive, participative nature, ensuring the interface between offer and demand on a much more rigorous volume and structure area, in space and time. The role of the consumer is increasing, moreover in terms of his ability of becoming an important source of innovational ideas for the producer or of innovation forcing, for market maintenance or growth purposes, for increasing the comfort level or for increasing the sustainability level of the economic growth.

Competition and cooperation represent two inseparable **sides** of the new economy, taking into account the interaction between demand and offer. The competition manifestation forms between producers are radically changed by the priority granted to a consumer which is continuously and rapidly changing in respect with his needs, tastes and demands, thus forcing competitors to cooperate.

The new economy respects the principle according to which "*the more persons are involved, the larger the advantages for each involved party*".

The micro- and macro-economical effects of the new economy are grounded on the principles which are generally valid to its development, namely:

a) **awareness;**
b) **accessibility;**
c) **availability;**
d) **affordability.**

The analysis of the economical and social life on a global scale emphasizes the fact that theories on economic growth have succeeded only in part, upon the scale of reduced population size, to solve the development related issues, and that such have severe consequences in respect with economical-social and ecological disequilibrium. In time there could be noticed that the development of some can only be achieved by other's becoming poor, by irremediable environmental pollution or by destroying the planet's other life forms.

In this respect, the Canadian Professor Bernard Hodgson (Bernard Hodgson, 2002) raised the problem of morality of uncontrolled economic growth as an imperative aspect and reality of the economic liberalism. He draws the attention on the following fact: the increase serving only to satisfying endless desires can undermine the liberal dimension of the liberal growth ethics, due to constant manipulation of the consumers and due to the real consequences of the economic growth over the environment, given negative externalities. "*It is ironic that the growth receipts in a liberal market economy, promoted both by technologic advances in production,*

and by the uncontrolled consumerism can only reduce the choices of both the producer and the consumer, choices representing the very essence of a market economy based system".

Hodgson promoted economic theory reconstruction in a moral view, due to the inherent morality of the human action and he also demonstrated that economic theories could not be neutral in respect with the values they promoted, but that they were of normative nature, promoting moral values.

1.2. The concept of enterprises "corporatist social responsibility" – unrevealing the essence of responsibility

The theoretical-pragmatic aspects have been put into practice by creating the enterprises "corporatist social responsibility" concept. A new vision on social positioning of such, it describes the enterprises' functions system. "*The main function of an enterprise is to create value through producing goods and services that society demands, thereby generating profit for its owners and shareholders as well as welfare for society, particularly through an ongoing process of job creation. However, new social and market pressures are gradually leading to a change in the values and in the horizon of business activity*"[4]. In view of such social function, the concept of "corporatist social responsibility" particularizes what organizational behavior means. "*Most definitions of corporate social responsibility describe it as a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis"*[5].

The concept introduced by the European Union aims a behavior change on an organizational level. Enterprises should fulfill their legal obligations, exceeding the existent agreements, and by voluntarily undertaking new and important social obligations and responsibilities which are not (directly or indirectly) generated by the demands of obtaining profits for owners or stakeholders.

The range of these new responsibilities is extremely varied.

a) On internal level (regarding enterprise related activities) corporate social responsibility can refer to:

- Investing in the human capital, such as: employees training in permanent learning, employees empowerment based management, ensuring a better personnel training, promoting more harmonious

[4] *Corporate Social Responsibility. A business contribution to sustainable development*, 2002 Commission of the European Communities COM/2002 347 final

[5] Green Paper. Promoting a European Framework for Corporate Social Responsibility, 2001, European Commission, Luxemburg, p. 8

rapports between work, family and spare time, a larger labor diversity, equal payment for women and equal promotion chances for them;
- Un-discriminatory practices regarding ethnical and national minorities;
- Labor security and employees health safety on the job (others than those which are legally mandatory);
- Managing the impact over the environment and the natural resources: reducing the natural resources consume, pollution, energy waste, practicing the "win-win" opportunities relation (good for both the business and the environment).

b) On external level (regarding a company's activity "beyond its doors" – local community, shareholders, partners, suppliers, consumers, public authorities):

- Integrating the company in the local community by providing jobs, incomes (benefits and services), cooperation with other enterprises (especially SME) and contribution to the viability of such, training employees and ensuring the possibility of allowing them to be employed by other units etc;
- Protecting human rights in respect with local community and with the activities on an international level and channels of global offer, promoting exemplary relations in terms of moral, legal and political aspects on a local plan and in regards to the environments outside the community;
- Voluntary involvement in complying with the prerequisites for a clean global environment;

In view of these visions and social experiences, detailed knowledge of nowadays' characteristics and behaviors will lead to a better approach of all challenges generated by contemporary processes and to the implementation of new methods and methodologies able to help mankind to face the Responsibility Century.

1.3. Prospectus regarding the concepts of "information" and "knowledge"

a) Information, driver for social welfare

Grounded on Moore's synthesis[6], four aspects can be underlined regarding the economic role of information:

[6] Moore, N., *The Information Society*, World Information Report 1997/98, UNESCO Publishing Paris, 1997

- **Information is a resource** for organizations and private individuals, becoming the main source of welfare for companies and individuals;
- **Information represents the grounds of new** rapidly growing **economic areas**;
- **Information can be used in common without being consumed**;
- **The development of information and communication technology** (ICT) **revolutionizes fundamental activities of the human society**: business, education, governing, and enterprise management.

Thomas S. Wurster and Philip Evans (2000) provide extremely interesting opinions on the **economic role of information**, quoting a highly appreciated article they previously published in Harvard Business Review. The authors regard an enterprise's activities in view of two elements: *information and works*. The production physical world takes shape by information, yet in the economy of an activity an *information economics* combines with an *economics of the things that are fundamentally and qualitatively different* (only if we refer to the fact that sold or transferred information is not lost, whilst physical things are finally transferred). Internet and electronic networks create an information flow which is ever larger, distinctly of physical things. That is why the old connection between the physical object and information is broken. Yet, a connection remains, however released of any immediate constrain. This leads to valorizing a large latent economic potential which is transformed into value.

These authors draft a **theory of information richness and reach**, by means of which they interpret the effect of the information economics in the context of relative, yet pronounced, separation from physical things. The theory also applies in the case when the main product is information. **Information richness** is not only the information quantity, but it also refers besides such (for instance, the transmission ribbon allowing only for text if it is narrow or moving image if it is larger), to interactivity, to the extent in which it can be purposefully prepared for the addressee, to information correctness, to information security etc. Information richness actually means information quality. **Reaching information** refers to the number of people who can receive certain information.

Wurster and Evans ascertained that as long as information is comprised in the delivered physical things, a basic law exists governing its economy: *the* ***larger the information richness, the lower its reaching is***. This can be also easily understood on an intuitive standpoint.

Electronic commerce is an example of high reach level economy. However, the *browsing* phenomenon, without which reach would be

un-organized. It is important to achieve a reach level that could ensure *critical mass* of beneficiaries, unless for which value creation could no longer be ensured. The critical mass refers to the area of information economy, and not of things economy.

b) Knowledge in view of intellectual capital

Knowledge represents intellectual capital, what is learned in an organization: "*no other sustainable advantage exists than what a company knows, how it can use what it knows and how fast it can learn something new*". Bohn noticed[7]: *„information is much easier to store, describe and move than knowledge*". This author mentions that it is important to understand **technological knowledge**, meaning knowledge regarding the way of producing goods and services.

Bohn, as well as others, operates a distinction between data and information, and between information and knowledge:

a) Data are obtained directly from measuring one or more variables.

b) Information represents data which have been organized or structured in a certain way, placed in a context and having a particular meaning. Information shows the status of the production system or of a part of such.

c) Knowledge is much more than that. It attempts to understand the process, to produce cause-effect associations and to make predictions, to take prescriptive decisions. Bohn defines **technological knowledge** as the understanding of the effects of input variables (x) over output variables (Y). Given Y = f(x), technological knowledge is knowledge on the arguments and behavior of f(x). It must be also remembered Bohn's definition for the learning concept: *learning is the evolution of knowledge over time*.

Knowledge cannot be measured only by its effects. The idea has taken shape of knowledge not as a stock, but as a flow, and it is in exactly that flow that the combination is manifested of experience and inspiration from people creating knowledge and applying it in technologic processes and in business management. In a **knowledge-creating company** knowledge is not a specialized activity of the research and development department. It is a behavior modality, a way of being. In such a company, each individual is a knowledge worker, also meaning an enterpriser.

1.4. Is knowledge the novelty of global economy?

In order to answer to the question "**Is knowledge the novelty of global economy, or not**" we consider that we should first of all consider

[7] Roger E. Bohn, *Measuring and Managing Technological Knowledge*, quoting Dale Neef (coordinator)

the following aspects which are closely connected to the issues involved by the notions of information and knowledge, namely: "Have knowledge and information always existed?", "To what extent do they influence nowadays, more than ever, mankind?", "Are people only now starting to act according to the knowledge they have?".

By analyzing the recent papers on complex issues such as "The New Economy", "Knowledge or information based society" (concept also found in the specialized papers published by Ovidiu Nicolescu), "Internet", there can be ascertained that the novelty of global economy is generated by the very occurrence and making use of a new economic factor: knowledge[8]. The arguments in this respect refer to the fact that during the last 50 years the production factors have been earth, work and capital, and that the role of knowledge has been neglected as distinctive production factor. James W. Michaels (1999) described as it follows the age undergone by mankind: Stone Age; Iron Age; Agriculture Age; Industry Age; Technology Age; Knowledge Age.

In a graphic form, he presented such in the form of interconnecting time waves each with a growth segment followed by decline in favor of the new growing wave. The last considered wave (age) is the knowledge age, the growth of which is predicted without showing what could follow next. These ages are recorded on an ascending scale in respect with the value they create, and the most effective from this stand point is the knowledge age. The opinions of James W. Michaels are probably the first theoretical conceptual inclusion of the knowledge society in line of the human history. The lack of *information age* could be surprising, as such is not explicitly mentioned, however it is most likely divided in the author's vision into technology age and knowledge age, the last mentioned one representing the higher part of the information age. Actually, in the opinion of most specialists mankind is currently undergoing the information age, the successive phases of which are:

a) The information society;
b) The knowledge society;
c) The conscience society.

Knowledge society is much more than informational society and informatics society. Actually, the last two mentioned ones are included in the knowledge society. From the moment when Internet intervenes, with its great advantages (e-mail, electronic commerce and electronic transactions, Internet market), by including in the electronic information area as many

[8] Dale Neef (coord.), *The Economic Impact of Knowledge*, Butterworth-Heinemann, Boston, 1998

citizens as possible, the shift is made towards informational society. Knowledge is meaningful information and acting information. That is why knowledge society is not possible unless connected to information society, of which it is inseparable. In the same time, it is much more than informational society by the major role of information – knowledge in the society. The best meaning for knowledge society is probably that of **informational and knowledge society**.

The name of knowledge society is nowadays used worldwide. This name is short for knowledge based society.

The European commissioner Romano Prodi, chairman of the European Commission sometimes uses the concept of knowledge based economy. In 2001, Deutschland magazine published a special edition dedicated to knowledge society, in which Sther (2001): „*The social order taking shape in the horizon is based on knowledge. […] The knowledge volume at our disposal is doubled every five years. […] Knowledge is becoming more and more basis and principles guiding people's activity. In other words, we are organizing reality by the knowledge we have. […] If the main feature of the modern society is knowledge, then knowledge production, reproduction, distribution and achievement cannot remain unpolitical. One of the most important issues we will confront during the next decay will be how to monitor and control knowledge. This will lead to the development of a new branch of science policy: knowledge policy. Knowledge policy will regulate the rapidly increasing volume of new knowledge in the society and it will influence its development*".

The question to which we have decided to reflect throughout this subchapter, "**Is knowledge the novelty of global economy, or not?**" is answered in the aspects described in the following. Information and knowledge regarded in their essence have always existed. The novelty is not the use of knowledge, because mankind has always depended on this aspect. The novelty is that Informational Society and Knowledge Society are capable to answer to the needs of the moment. The question arises however: "Why a knowledge society? Hasn't the evolution of the human society so far based on knowledge?" The novelty arises from:

a) The speed by which knowledge are renewed (it is known that the knowledge volume at our disposal doubles every five years);

b) The nature of the moving force animating social, economic and cultural changes exceeds the world of informational technologies.

The renowned sociologist Peter Drucker has mentioned important changes in the society. Regarding the integration of new technologies, Drucker mentioned that: "*The world resulting from the current rearrangement of values, beliefs, economic and social structures, political concepts*

and systems, in other words of the views over the world will be different from what one could imagine today. In some areas – and especially in respect with society and its structure – fundamental changes have already occurred. The new society is actually certitude, and it is also certitude that its primary resource will be information".

2. The New Economy

Specialists forecast that the 21st century will represent a singular historic point, and that the evolution speed of tools will overcome human assimilation and development capacity. This overcoming will produce a shock wave equivalent to exceeding the sound level.

The future is of real time on-line activity. In other words, the future is of societies understanding to transform as a whole into an active network and succeeding in speeding up its evolution or the self-organization of which is integrated in the worldwide system, in the same time maintaining the identity and control in the national sub-system grounded on universally accepted rules.

The importance of time and decreasing distances represent the true challenges of the 21st century.

The **time factor,** variable of economic growth, implies revealing at least two aspects regarding economic growth, by means of which its analysis becomes more thorough, namely: how long is the period in which the economic growth is achieved and how macro-economical indicators and total population evolve within the considered time interval.

The **time factor** is becoming significant both in terms of the fight against resources' rarity, by rationalizing choices, and of the equal chances for generations, grounded on the social-human value of hope.

Specialists consider that the information technological paradigm is not evolving towards closing, but towards opening. The information technological paradigm is regarded as a strong force penetrating down to the heart of life and spirit. Mankind evolution should be regarded in close correlation with the multitude of development factors, with the complexity of the economical-social life, of the culture, identity and not last of the environment.

2.1. The New Economy versus the Old Economy – historical and theoretical aspects

The present paper provides a brief description of the differences between the New Economy and the Old Economy, grounded on the

evolution of such elements from a historical stand point, also considering the implications of theoretical nature.

Richard Boulton described the difference between the old economy and the new one as it follows: in the first one, the **tangible goods** are important, whilst in the second mentioned one, there are of importance the **intangible goods (assets)** which create value. Intangible is immaterial, difficult to describe and moreover to quantify and measure. Intangible assets (goods) are valuable and they create value.

In respect with **intangible goods**, classifications represent guidelines and many comments on such can be made, yet the one proposed by the European Commission provides a clear picture over their structure[9] (see table 1).

Table 1

Company Assets Structure

A. INTANGIBLE GOODS	**Human capital**	Continuous training Knowledge networks Entrepreneurship Personnel and know-how Company values Managerial skills
	Customers capital	Clients network Marketing strategy Goodwill
	Organizational and functional capital	Company structure Functioning (operating) procedures Research and development organization Suppliers network Data bases and software Information processing systems. Other procedures
B. TANGIBLE GOODS	**Physical assets**	

The actual structure of the New Economy can be schematically illustrated as it follows: "The New Economy – Digital Economy (Internet market) + Acknowledging the value of intangible goods and their use, mainly knowledge + Ensuring social sustainability compared against the environment + New economic rules arising from the first three prerequisites".

The evolution of the new economy should not be limited to the information sector, which represents a process of extended consequences in the old, traditional economy. In the same time, the new economy does

[9] European Commission Enterprise DG – European Observatory on Intangible Assets, Policy Trends in Intangible Assets, 8 Nov. 2000, http://www.eu-intangibles.net.

not necessarily imply growth rates for the entire economy, which could exceed the average performances of last years.

Gordon and Gundlach take a **critical standpoint** regarding the new economy's potential of increasing productivity, taking into account the failure and even collapsing of several known companies in the new economy (*dotcoms*) in years 2000 and 2001, the slow down of the economic growth in the United States in 2001[10]. In conclusion, a more realistic assessment of changes induced by the new economy becomes essential, in case a correct reflection is pursued of the nature and implications of the new economic processes.

2.2. The New Economy – theoretical aspects

A term which has been more and more used in the last period is New Economy. In knowledge society a new economy really takes shape, also incorporating the Internet economy. That is why the new economy is the economy of information and knowledge society.

The term of **new economy** has been increasingly used during last years[11]. The rapidity by which the informational society is transforming into an information and knowledge society generates an understanding of the new economy that considers not only the **Internet market and the effect of information on the Internet over all economic agents**, but also the **effect of knowledge as economic factor** imposing acknowledgment of the intangible goods in general, in creating economic value, as well as by the **demands of achieving sustainable society**, *which besides the fact that it is impossible unless for a knowledge society, will also impose in the social economy new industries, orientation changes in relation to the classic economic thinking* (for instance, resources, energy, materials productivity before labor productivity)[12].

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[10] See Gordon, R., *Does the „New Economy, Measure Up to the General Invention ofthe Past?,* in Journal of Economics Perspectives 14(4), 2000 and Gundlach, E., Interpreting Productivity Growth in the New Economy; Some Agnostic Notes, Kiel Working Papers 1020, Kiel, 2001.

[11] *Conferinta Noua Economie – O şansă pentru România (Conference The New Economy – A Chance for Romania),* organized by Arthur Andersen and Oracle, under grant of the Romanian Prime-Minister, Adrian Nastase, in collaboration with the Ministry of Communication and Information Technology and the Ministry of Industry and Resources, Bucharest, Marriott Hotel, 20th of March 2001.

[12] Ernst Ulrich von Weiszăcker, Amory B. Lovins, L. Hunter Lovins, *Factor patru. Dublarea prosperității prin înjumătățirea consumului de resurse*, Report for the Roma Club, Editura Tehnica, Bucuresti, 1998 (translation from German language).

The concept used by Romano Prodi, the chairman of the European Commission, namely that of knowledge based economy (which he regarded as equivalent to the one of knowledge based society) is closer to the standpoint expressed herein[13]. Often the concept of knowledge based economy or knowledge driven economy is shortened in the form of knowledge economy, more and more used along with the notion of new economy.

The new economy is based on creating knowledge, on using information in the economic area, mainly by innovation.

Given the nature of the new economy, it has been attempted to define it by means of a series of concepts, such as:

a) ***Digital economy***, because it refers to goods and services the production, development and sale of which essentially depend on digital technologies;

b) ***Information economy***, because it includes all goods and services regarding informational technologies, such as: research, legal and banking services, financial services;

c) ***Virtual economy***, because the environment in which transactions take place is not a physical, but a virtual one;

d) ***Internet economy***, because the working environment is the Internet;

e) ***E-commerce, e-banking*** and **e-economy**.

Two American authors, Kling and Lang[14], suggest certain taxonomy in their attempt of introducing a systematization of the new phenomenon. Thus, they suggest that the term of **information economy** should be used for the area of informational goods and services (from research and education to advertising and show-biz). Also, they recommend the concept of **digital economy** in the case of those goods and services where research – development – production – sale are vitally dependant on the digital technology.

As regards to the term of **new economy**, these authors view as appropriate to use it in case of **interaction between *information economy* and *digital economy***, in order to emphasize the resulted consequences, such as high growth, low inflation and a low unemployment level.

Essentially, the new economy represents a wide concept describing an economy in which both the final product, and its intermediary stages,

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[13] Romano Prodi, speech at the German Confederation of Trade Unions' (DGB) Federal Presidium, Brussels, 7 November 2000, apud Cordis Focus, European Commission, 20 November 2000

[14] Kling, R., L. Roberta, *I. T. and Organizational Change in Digital Economics. A Sociotechnical Approach*, in E. Brynjolfsson, B. Kahin: *Understanding the Digital Economy-Data, Tools and Research,* MIT Presse, Cambridge, Massachusetts, 2000

represent information, and in which modern digital technologies provide worldwide access to all information available upon a certain moment. These new technologies have the role of enhancing efficiency in the conventional, traditional business practices and of easing the occurrence of new processes and products.

The new economy can no longer be reduced to **digital economy** (or the Internet), because besides the informational and knowledge society objective, in the 21st century mankind should also achieve the stage of ecologically sustainable society[15]. This objective, on which mankind survival depends, cannot be fulfilled without knowledge and knowledge management.

2.3. The New Economy and the implications of the innovation processes

Knowledge economy represents a New Economy in which the innovation process (the ability of assimilating and converting new knowledge in order to create new services and products) is becoming decisive.

Innovation in the knowledge society aims to improve productivity, not only in respect with work and capital, but also in respect with the natural energetic and material resources, and with environmental protection. That is why the new economy implies encouraging the creation and development of innovative enterprises upon its own knowledge structure.

Innovation in view of the new economy **represents the capacity of assimilating and converting new knowledge in order to improve productivity and to create new products and services.**

The informational society has created the **Internet** market. The new role of information in the Internet context has opened the period of a new economy. The influence of Internet as a market in the informational society is the acknowledgment of the intangible goods' (assets) value. Knowledge represents a feature of the new economy.

3. Fundamental problems of the New Economy – recreating the spirit of the New Economy

According to the studies undertaking the problems of the new economy, there should be noticed that a series of aspects exist which should

[15] Acad. M. Draganescu, *Societatea informațională și a cunoașterii. Vectorii societății cunoașterii* (*Information and Knowledge Society. Vectors of Knowledge Society*) Chairman of the Science and Information Technology Section with the Romanian Academy, 2001

be taken into consideration. The following questions exist: “Can the issue of global poverty be overcome by means of the New Economy, or not?”, “Will the New Economy aggravate the issue of global poverty, or will the new techniques and technologies, once implemented, be able to cut down or to diminish the major disequilibrium faced by mankind today?”, “Can we speak of sustainable development or of healthy development in case of the world countries?”, “Is mankind getting closer or rapidly getting away from sustainable economic development?”, “Can we consider organizations today as really competitive?”, “Which are the elements for a healthy organization and can such elements be found in the New Economy?”, “Will mankind be able to diminish the problems arising from underground economy?”, “Is it possible for the gap created by the New Economy to be diminished by implementing safer means for performing internet transactions?”, “Can we speak of really efficient control in the New Economy?”.

The responsibility for scientific knowledge is the one which will lead to increasing worldwide competitiveness. The issue of inter-human competition generates a series of negative aspects, which can be also seen nowadays consequent to the existent major disequilibrium between world countries.

The individuals’ entering competition with the other individuals has generated the worst miseries (the nuclear bomb, the creation of chemical weapons, the possibility of generating mutations of any level, the occurrence of cloning even in the case of humans). What is really important is to create the conditions for each individual to be able to compete with oneself. Only in this manner will the real individual values be maintained and the responsibility spirit will be disseminated upon all social levels.

The issues of the economical-social development are interacting closer and closer in time and space, given the context of increased role of the assembly over its components. Thus, the basis are established of a new **economic theory of development** in view of **rationality**, given the limited resources and **hope**, based on the ethics of equal chances for coexisting and succeeding generations.

The macro analysis of the economical processes, along with their dynamic approach, has shaped new concepts, among which those regarding economic growth and development. Among the numerous notions used in order to investigate macro-economical processes, the most frequent are the terms of growth, development, technical progress, economic evolution, economic cycle etc. In respect with the sense for the mentioned terms, smaller or larger differences exist between various authors, and also certain convergence points, which make the said notions to be of universal nature.

Economic growth takes place in a certain space and time. The new social order imposed by sustainable human development is grounded, in view of specialists, on eight basic principles: refreshing economic growth; a certain quality of the economic growth; conserving and developing the resources base; ensuring that population development level is maintained; technological reorientation and risk control; integrating the environment and economic processes in the decision making action; reforming international economic relations.

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THE ROLE OF EXPECTED AND PERCEIVED INFLATION IN THE DYNAMIC OF INFLATION IMPLICATIONS ON THE COST OF LIVING[1]

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Abstract: *In this paper we study the role of expected and perceived inflation in the dynamic of inflations. We review the topic of the inflation expectations and its importance for economic policy. We also review different methods to quantify expected and perceived inflation. In the end, we draw some possible implications on the cost of living.*

Keywords: inflation, perceived inflation, expected inflation, cost of living.

1. Introduction

The expected inflation plays a key role both in the macroeconomic dynamics, and the financial markets, and within the different economic policies. For example, as the central banks started to adopt the inflation targeting (IT, hereafter) regime, the measuring and forecasting of inflation has become an essential issue in the process of the implementation of monetary policy. Also, at the level of different social policies, the importance of expected inflation comes from the necessity of computing in a correct way both the cost of living and the correlations between the different social measures and the expected inflation.

During the last ten years, the debate on the official inflation and the perceived inflation was centered on the difference in the perceived inflation by consumers and the official inflation. The debate tried to answer the important problems regarding the efficiency of the official indicators that measure the inflation. These debates were sustained by the results obtained, which illustrated the growth in the gap between the official inflation measured by the CPI and the perceived inflation as measured by the surveys of the European Commission (see European Central Bank (2002a, 2002b,

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2003 şi 2005), European Commission (2004), National Bank of Belgium (2002) and Deutsche Bundesbank (2004)).

Although the problem of the gap was ample debated within the European Union, this problem was less debated in Romania. Discussions were focused on the analysis of the methods to measure official inflation and on the ability of the CPI to measure the cost of living in a correct way. In this sense the National Institute of Statistics (NIS) computed for 2000 the monthly inflation rates using different indices (Lasspeyres, Paasche, Fisher). The results illustrated the fact that the inflation computed as the cost of living is higher than the official inflation.

The relevance of the gap between the perceived inflation and the official inflation is illustrated by Paolo Del Giovane şi Roberto Sabbatini (2005) which revealed a series of elements which confirm the importance of this gap. The gap affects the capacity of the consumers to correctly identify the prices of economic goods which leads to a decrease of the efficiency of allocating the goods, it influences the expectations with respect to the future dynamic of prices and can distort the decisions regarding the prices and wages, it affects the credibility of the monetary policies, and in the cases of the countries that adopted the Euro, it also affects the public acceptance of the currency and the confidence in its stability.

Previous contributions regarding the expected and perceived inflation comparative with the official inflation were done by Pelinescu and Dospinescu. Pelinescu and Dospinescu (2006) analyzed the differences between the perceived and official inflation. They showed that if the perceived inflation is an approximation of the cost of living, then there is a tendency over over-perception of inflation.

The present study continues the previous studies, and it treats the importance of the expected and perceived inflation in the dynamic of aggregate inflation and the implication on the cost of living.

2. The inflation measured by the CPI, expected inflation, perceived inflation and the cost of living. Theoretical Observations

The CPI, the index of the consumer prices officially computed, reveals the changes of the consumer prices based on a consumption basket in which the weights of the goods in the basket are corresponding to the real weights in the consumption expenditures of the population.

The computed index of prices is, usually, a Laspeyres in which the prices in the current and base period are weighted with the weights from

the base period. This method has its own limitations which were theorized, and revealed and numerous studies which a significant impact, like those of Boskin Report (1996), Schultze şi Mackie Report (2002), Bryan şi Cecchetti (1993), Nordhaus (1998). The fore mentioned authors revealed limits in the construction of the index of consumption prices and measuring errors which are registered due to this limit.

Beyond these measurement errors which are related to the way the price indices are constructed, we deal with mis-measurements which have deeper causes which are related to the differences between the mathematical and statistical constructions of indices and the process of perceptions of prices and consumptions. These differences are subtler and more difficult to solve. For example, the prices indices officially computed consider the changes of prices in a symmetric way, in the sense that the positive and negative deviations from the base prices are treated differently. However there are some questions related to the way the consumers perceive inflation, as it is possible that prices fallings are not perceived as the prices risings are perceived. For these reasons, an index of the inflation perception is symmetrical.

The expected inflation is measured using the surveys realized at the level of samples by households and tries to quantity the expectations regarding the future dynamic of inflation by economic agents. For the EU member countries, the main source of current information is the European Commission survey at the consumer level. The survey addresses questions related to inflation, unemployment, the income growth, etc.

As for the dynamic of inflation, the survey addresses two types of questions, one which is forward looking, related to the expected inflation, and a backward looking question, both questions containing six possible qualitative answers:

The backward looking inflation: „How do you think the CPI developed during the last twelve months" has as possible answers the following: 1. It increased more. 2. It increased moderately 3. It increased slightly 4. It stayed at the same level. 5. It decreased 6. I don't know".

The forward looking question refers to the expectation of the respondent with respect to the dynamic of inflation in the next 12 months, as compared to the previous 12 months. The possibly answers are six: 1. They will increase faster. 2. They will increase at the same rate 3. They will remain at the same level 5. They will decrease 6. I don't know

This survey is done each month, and it studies the dynamic of inflation given by HICP, the harmonic index of consumption prices.

The perceived inflation reflects the perception of the consumers with respect to the past dynamic of prices. The computation of the index of

perception of inflation is based on the survey program applied at the level of European Union (the Joint harmonized EU program of business and consumer surveys).

Within the consumers 'confidence indicators, the backward looking questions (Q5) and (Q6) quantity the perception of the consumers with respect to the past and future price changes. The perception indicator reflects the impact of the prices modifications on consumers. In this respect, the indicator is influenced by psychological factors. The consumers perceive more acute the prices modifications of the goods and services bought more often or those which have a higher impact on their consumer basket. Researchers suggest even a stronger hypothesizes indicating a fundamental difference between CPI and the perception indicator. For example Kahneman (1979) identifies a cognitive bias of the consumer namely the tendency to perceive more acute the losses then the wins, even if those two are of the same magnitude. In this context the consumers have an aversion to lost. At the same time the perception may be affected by an isolation effect, namely the consumers perceive the modification of prices separately without taking into account the connection between their modifications. The consumers are not rigorously analyzing all the changes in prices. In this respect, the literature on price modification is numerous see for example Del Giovanne şi Sabbatini (2005), Fluch şi Stix (2005), Brachinger (2005), Dziuda şi Mastrobuoni (2005). The concept of perception errors is a relative one. It can be understood in the sense that the consumer tend to misspercepive. We think the focus should not be on the missperception *but on the fundamental differences in constructing the indicators, we have matemathical and statistical instruments in the case of the consumer price index and psihologycal mechanisms in the case of the inflation perception indicator.*

In the analysis of the cost of living indicator there are debates focusing on the differences between this indicator and the consumer price index. Recent studies analyzing the case of developed countries showed that the consumer price index tends to overestimate inflation and that it is higher then the cost of living indicator. The differences come from two fundamental sources: the differences in the economic phenomenon reflected by the indicator and the differences in the method of calculation. In conformance with the definition proposed at the International Conference of the Labor Statistics, November 1987[2], the consumers' price index measures "the evolution of the level of prices of goods and services bought to be consumed". The cost of living indicator measures "the level

[2] Dr. Filofteia Panduru, *The Consumer Price Indices, Methodological options* paper presented on the Seminar Onicescu, September 6,2002, INSSE, p. 1

of the consumers' utility, the rate of the minimum cost necesary in order to achieve a certain living standard"[3], thus the indicator has a built in relation between two structuraly different goods and services baskets[4]. In Romania the consumer price index measures "the evolution of the goods bought and of the prices of services used by the population between a certain period (current period) and a past period (base period)"[5]. From the definition of the consumer price index it results that if the consumer behaviour remains unchanged, then the substitution elasticity between two products is zero and the level of this indicator reflects the true cost of living.

The studies of Menser şi Mc. Donald (1988), Aizcorbe şi Jackman (1993), in United States suggest that the consumer price indicator calculated using Laspeyres index is 0,2 procentual higher then the indicator reflecting the cost of living. The papers do not identify the source of the differences, namely if the differences comes from the price modifications or from modification in the consumer basket. More recent studies for example Gordon (1995), Boskin et all (1995), şi Diewert (1995) suggested that the difference are higher 1% annualy in the United States, a much higher level then the one calculated by Wynne şi Sigalla (1994), Lebow, Roberts şi Stockton (1994), Pakes (1995). A general picture of the magnitudine of these effects[6] in the United States and in the transition countries can be found in Koen şi Masi (1997). Their analyisis is made on annual data and focus on the corelation between different goods and services included in the consumer basket. The results suggest that the correlation coefficients for the transition countries are in the band 0,7 and 0,9 and ocazionaly for some good 0,4; in comparance in the United States the value converge to 0.99. For Romania our computations for the period January 1994-September 2002 indicates a varation of the coefficient in the band 0,6 and 0,95 and ocasionally values under 0,1 for rent and termic energy; 0,2 for fruits; 0,3 for oil; 0,4 for CFR tarifs. These values are much lower then the group with a coefficient of 0,954 for food goods, 0,941 for non-food goods and 0,872 for services.

Kornai (1992) highlighted a specific factor in the transition coutries, namley the unsatisfied demand of the population which in it turn trigered an increase of prices after liberalization, generating a preasure in the

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[3] Jan Hanousek şi Randal K. Filer, *Evaluating Imperfections and Biases in Price Index during Transition*, BCE, 2000, p. 4

[4] Dr. Filofteia Panduru, *The Consumer Price Indices, Methodological options,* paper presented on the Seminar Onicescu September 6,2002, INSSE, p. 1

[5] *Ibidem*, p. 3

[6] For the transition countries, the magnitude of deviations there are on the inflation studies writed by Brada, King şi Kahan (2000), Filer şi Hanousek (2000) şi Duchene şi Gross (1994

direction of the increase in production. In these cases the Laspeyres index underevaluates the true increase in the cost of living, the intensity of the undervaluation variates from country to country and from period to period depending on the price liberalization strategy and the intensity of reforms. In this context, the analyses suggest that in the periods when the perception of inflation is higher then the statistical inflation indicators then this indicates a perception of a cost of living higher then the one suggested by the evolution of inflation. In this context, the expected inflation will in it's turn register higher values then the official measurements of price modifications.

3. Methods of measuring of the inflation expectations, perceived inflation and cost of living

One of the most used methods to quantify the surveys data, for the qualitative answers with respect to the future dynamic of inflation, is the probabilistic approach.

Theil (1952) constructed one of the first methods to quantify the expectations regarding inflation using the probabilistic approach. He succeeded to build a more rigorous method than that based on the balance statistics.

Lyziak (2003, p. 11) underlined the fact that there are two fundamental elements in the probabilistic method, namely:

1. Each individual has a probability function over the expected changes in prices. This function has a determining role in the questions from the survey;
2. It is assumed that if the expected price change falls in a zero-centered interval, namely a $(-s, +s)$ interval, the respondents will report that prices will remain the same.

Two of the most used methods to quantify the expectations of the individuals are the adjusted method of Carlson and Parkin (1975), and the uniform method, from which we present only the first.

We follow here the presentation of Lyziak (2003, p. 11). It is assumed that *a* stands for the percentage of individuals that expect the prices to grow faster, *b* stand for the respondents that expect the prices to grow with the same speed, as a percentage from total respondents. We use *c* to denote the percentage of those who expect that prices will increase slower inflation, *d* those who expect a constant inflation and *e* those respondents who expect that prices will decrease.

We use π^{e}_{+12} for the expected rate of inflation in the next 12 months. We assume that this variable is normally distributed, with parameters m for mean, and σ^2 for variance.

The adjusted method of Carlson and Parkin implies that the interval centered on zero is endogenized.

Lyziak (2003) showed that the system can be written as:

$$a = P(\pi^{e}_{+12} > \pi_0 + s) = 1 - F(\pi_0 + s) \tag{1}$$

$$b = P(\pi_0 - s < \pi^{e}_{+12} < \pi_0 + s) = F(\pi_0 + s) - F(\pi_0 - s) \tag{2}$$

$$c = P(t < \pi^{e}_{+12} < \pi_0 - s) = F(\pi_0 - s) - F(t) \tag{3}$$

$$d = P(-t < \pi^{e}_{+12} < t) = F(t) - F(-t) \tag{4}$$

$$e = P(\pi^{e}_{+12} < -t) = F(-t). \tag{5}$$

The system can be rewritten by using the normalization relations, see Lyziak (2003) for details:

$$F(k) = Nz\left(\frac{k-m}{\sigma}\right). \tag{6}$$

After the system is rewritten using the normalization equation, the system can be easily solved. The solution is given by the following equations:

$$m = \frac{\pi_0(C+D)}{C+D-(A+B)} \tag{7}$$

$$\sigma = \frac{-2\pi_0}{C+D-(A+B)} \tag{8}$$

$$s = \frac{\pi_0(B-A)}{C+D-(A+B)} \tag{9}$$

$$t = \frac{\pi_0(D-C)}{C+D-(A+B)} \tag{10}$$

where the variables A, B, C and D are given by:

$$A = Nz^{-1}(1-a), \quad B = Nz^{-1}(1-a-b), \quad B = Nz^{-1}(1-a-b-c),$$

and $D = Nz^{-1}(e)$.

The data for perceived and expected inflation were obtained from the Joint Harmonized EU Programme of Business and Consumer Surveys. The survey permits us to obtain qualitative data. The survey uses as a

center value the formulation rise slightly. The choice for the central value of the scale is interesting taking into account that the scales usually use neutral formulation as a center data. *The formulation suggests that we have "a built in compensation"* for the aversion to lost effect identified by Kahneman (1979).

The data for perceived and expected inflation are not compatible with the CPI data. In order to obtain compatible data there can be used a number of methodologies. We are going to present two methodologies.

The first methodology implies a simple "rescaling" of the survey data by dividing the original series by the standard deviation of survey data, on one hand, and multiplying them by the standard deviation of inflation, on the other:

$$\pi_{it}^{p} = \frac{B_{it}}{\frac{se(B_{it})}{se(\pi_{it}^{p})}} \tag{1}$$

where π_{it}^{p} represents our (transformed) measure of perceived inflation, B_{it} denotes the original balance statistic from the survey, and $se(B_{it})$ and $se(\pi_{it}^{p})$ stand respectively for the standard deviation of the balance statistic and the officially measured inflation (HICP or national CPI).

The second method is based on a linear regression where the endogen variable is represented by the annual variation of CPI and the exogenous variable is represented by perceived and expected inflation.

The transformation of the qualitative data in quantitative data heavily depends on the method used. The objective of the methods is a rescaling of the data so as to make them compatible with CPI. The first method ensures the consistent with CPI by linking the qualitative data to CPI using standard deviation. The relation between the standard deviation of the two series compensates for the differences in the level of the two series but the connection is not strong enough. The second method utilizes OLS, which minimizes the differences between the IPC series and the series for perceived inflation. The quantitative perceived inflation series obtain is based on the forecast of IPC. Thus it anchors more strongly the perceived inflation series to IPC.

The analysis of the cost of living suggest that the best indicators are the superlative indicators Fischer and Törnquist-Theil. This indicators are batter then the Laspeare index because of the statistical properties as reversibility and the small impact of the asimetry of the distribution.

Fischer Index:

$$I_F = \sqrt{I_L I_P} = \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} * \frac{\sum p_1 q_1}{\sum p_0 q_1}};$$

Törnquist-Theil Index:

$$I_{TT} = \frac{\sum_{i=1}^{n} p_{it} q_{it}}{\sum_{i=1}^{n} p_{t0} q_{i0}}.$$

The computation made by Jan Hanousek şi Randal K. Filer[7] for the Czech Republic shows that for the period 1993-1999, the Laspeyres index was higher than the Paasche index with 9,97% annually, and with 4,75% (except 1994 for which there weren't made any computations) then the Fischer index (used to measure the cost living)

On the entire period 1991-1999, the Laspeyres index indicates a cumulative increase of prices of 236,5%, superior to 207,3% indicated by the Paasche index and 221,5% indicated by the Fischer index[8].

In the case of Romania the differences between inflation measured by CPI and the cost of living indicator raised some questions regarding the accuracy of the inflation measurements. The computation of the specialists from the National Institute of Statistics indicates for the year 2000 that the cumulative inflation starting from December 1999, base on the Laspeyres index was 40,1% (published data), on the Paasche index of 40,92% and on the Fischer index of 41,09%. It can be seen that the relation between the three indexes is inversed for Romania comparing with the Czech Republic and with the countries with a stable market economy in general. The explanation resides on the modification in the structure of the consumer basket which operated in the same direction with the modification of prices and on the fluctuations of some relative prices which generates in its term asymmetries at the level of groups of products and at the level of the indicators.

At the same time we must look at the consumption behavior of households. The increase of the prices of goods bought more often by consumer increase in their turn the level of inflation as a cost of living the

[7] Jan Hanousek şi Randal K. Filer, Evaluating Imperfections and Biases in Price Index during Transition, BCE, 2000, p. 13

[8] According to authors J. Hanousek şi R. K. Filer the discrepancy could be greater because we assume for 1994 that there no deviations between the two indices taking into consideration the revision of the weigh of the Laspeyres indices on that year.

level being higher than the one of other indexes. The modification of the structure of consumption spending in the period 1995-2007 shows: a decrease with 8,1% of the weight of the spending for the food goods, an increase of 5,5% for the services and 2,63% for non-food goods as can be seen in Figure 1.

The increases in prices due to the modification of utilities prices up to the level registered in other UE countries and the liberalization of the prices of food goods had a considerable impact on the modification of the structure of the consumer basket before the Romanian integration in 2007 and after. For example beginning with January 2007 due to important modification in the budget for income and spending, the computation of CPI uses the weights from the structure of the average spending of households for the year 2005.

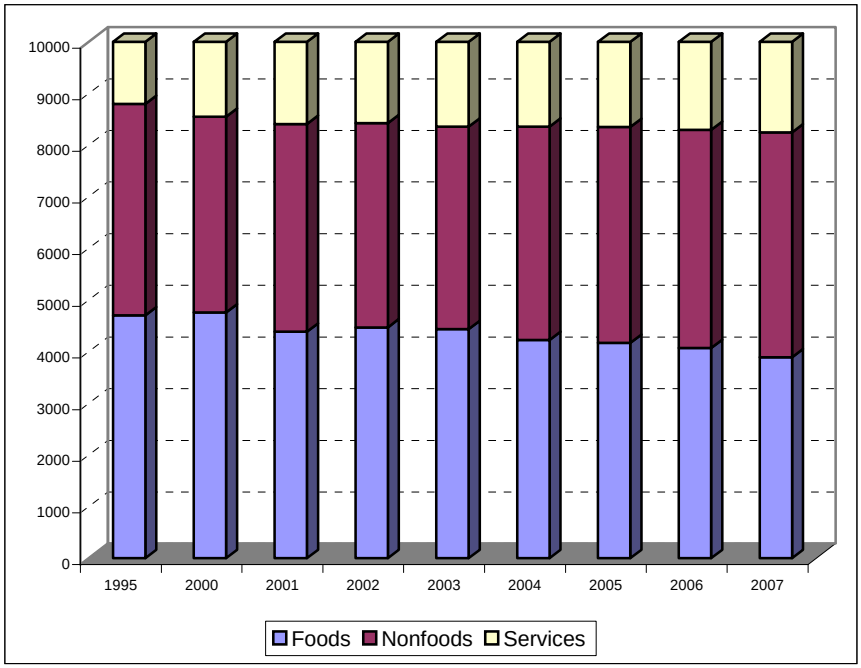

Figure 1. Changes of the consumer baskets in the periods 1995-2007.

4. Conclusions

The objective of the paper was to analyze the concept of expected and perceived inflation, the cost of living and the impact of the first two concepts on the dynamic of inflation.

The analysis suggests some interesting conclusions:

1. There are fundamental differences in constructing the consumer price index and the inflation perception indicator; we have mathematical

and statistical instruments in the case of the consumer price index and psychological mechanisms in the case of the inflation perception indicator.

2. In calculating perceived inflation based on the Consumer Surveys we have to take into account "a built in compensation" found in this surveys, namely we have "a built in compensation" for the aversion to lost effect.

3. The regression method used to construct a quantitative series for perceived inflation anchors more strongly the perceived inflation series to CPI

4. The differences between the cost of living indicator and CPI usually reflect the modifications in the real economy and there are not only due to differences in the methodology of construction.

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THE IMPORTANCE OF HUMAN RESOURCES IN THE NEW ECONOMY

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Abstract: *In the knowledge-based economy – the new economy it seems, by experts opinion – the firms meet the major challenge to find qualified personnel in labour markets defined by complex and erratic evolutions and above all by the lack of many categories needed in the process. The human resource gets more important, more complex and more expensive than before. That reality enhances the importance of MRU and the necessity to modify its contents.*

Keywords: human resources, knowledge-based economy, human resources management based on knowledge

1. Adopting the knowledge-based economy

During the last quarter century the economy of the developed countries evolved from the Industrial Era to the Information Era, from the capital-based economy to what has been called knowledge-based economy. One of the indicators of this transition is represented by the volume of the corporations' investments within the information technology. In the American economy it happened for the first time in 1992 that the volume of the expenses in relation to the information technology overtook all other investments expenses in equipment (Manasco, 2000, p. 1). Knowledge represents the new source of wealth – a category which has to be carefully treated as well as the proper capital.

Knowledge determine most frequently and often, decisively, obtaining the competitive advantage by the companies, without which these ones can neither develop nor survive. Some states such as USA are in an advanced stage of building of the new economy. Their previous years economic performances are edifying to this purpose. They represented the main argument which determined the European Union to draft the Lisabona Strategy by which it establishes what and how it should be acted so that the countries

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within should be able to build rapidly this new type of economy and to take over the advance that USA currently has. Essentially, **the knowledge-based economy** is characterized by transforming the knowledge into raw material, capital, products – essential production factors of the economy and by economic processes within which the production, the sale, the purchase, the learning, the storage, the development, the partition and protection of knowledge become predominant and decisively condition the obtaining of profit and ensuring the sustainability of economy on long term (Nicolescu and Nicolescu, 2005, p. 48)

2. Considering knowledge as an asset of the company

During the last decades the knowledge replaced the capital as a difficult to find production factor, thus becoming the dominant force in businesses. This dramatic change led to the current crisis of knowledge and to the search of solutions. In the Industrial Era the physical work based on manual skills was the source of economic growth and the ability to perform such labor the key to employment in the assembly line. The knowledge was something that allowed the work in the organization.

In the Information Era, on the other side, the intellectual work based on knowledge is the source of the economic growth and the capacity to do it represents the key of employment. Knowledge, by follow, does not represent some means to carry the work to the end – it's the work itself. The managers, the technicians, the experts in marketing and sales are those who provide administrative support, they all acquire and spread knowledge which is the current coin of their employment. They analyse, synthesize, create, perfect, in other words, they manage the intangible represented by knowledge. If the iconography of the Industrial Era was a pair of hands, the one of the Information Era is a pair of brains (Beazley et al. 2002).

The notorious specialist P. Drucker stated 15 years before that "the basic economic resource is not the capital, neither the natural resources nor the work. It is and it will be knowledge" (Drucker, 1993, p. 8). "The most valuable asset of a 21st century institution will be the set of knowledge of its employees and the productivity of their work" (Drucker, 1999, p. 135). This evolution from the focus on the educated physical work to the focus on the trained mental abilities is mirrored in the change of the aims of the businesses within the last 100 years. The aim of the Industrial Era was to automatize the human work. The aim of the Information Era is to develop and exploit the human knowledge.

The reveal of the superior quality nature and of the specificity of the knowledge-based economy does not signify in any way a unilateral approach of the economic system. Naturally, the system of the knowledge-based economy is not reduced only to knowledge. All the elements that the economic sciences named as economic activity inputs are maintained. Their weight within the economic circuits modifies and partially, their nature and modality to display, subject to the conditions in which the knowledge and the processes focused upon them usually have the decisive role. There is no doubt that the economic processes no matter how much they change they will always need also human resources, technical-material, financial etc., but in superior configurations and mechanisms, a result of the evolutions and accumulations.

During the two decades between ’80 and 2000 occurred the transformation of the value relation between the tangible and intangible assets. The ratio between them evolved from 1:1 (which means that the market value of a company practically means the value of its physical assets) to a ratio of 5:1, meaning that the intangible values are considered to be 5 times higher than the tangible ones. We might have returned to a ratio of 4:1 after the fall of the dot-com industry and the decline of the markets in the 2000s, but it will never fall to 1:1. The phenomenon certifies the value of the intellectual capital – a possible gain of the organization not related to the tangible assets (Beazley et al., 2002). The knowledge that the new economy is based upon is important for the companies with a low technical level, non-profit organizations, as well as for the companies focused on the top technique. To this purpose the former president of General Electric is being quoted, legendary Jack Welsh, who stated: “a good idea does not summarize to a technological idea. A good idea is to handle a process which requires a six days period and reduce it to one single day. We obtain growths of the work productivity of 6-7% mostly with this kind if ideas. Each person can have such contribution”.

For any asset, other than the intellectual one, the organization deploys high efforts to fight against its loss. The natural question is asked: why knowledge does not enjoy the same treatment? Ironically, it was settled a rigorous maintenance program in order to extend the life of the used devices but not a program for the preservation of the volume of the knowledge of the employees. However, the loss of these ones is in reality higher than in the case of fixed means which can be easily replaced.

If the knowledge was systematically transferred from the one who leaves to the one replacing him, bringing the latter to a maximum efficiency a couple of months earlier, the gain would be enormous based on this process only.

Unfortunately many organizations do not have a realistic perspective upon the value of the knowledge of the employees or of the costs for replacing it.

Although many managers strongly state: "people are our most important asset", these are rather treated like an expense. Acknowledging the knowledge "as a main engine of productivity" means to admit that people are not a cost but rather a catalyst of growth and wealth.

Otherwise there would be no point that the companies should take care of the tangible assets neglecting at the same time to their valuation by the equipped people.

3. Loss of knowledge in the new economy

Each generation of managers and leaders faced threats upon the profitability and sometimes the uncertainty of the survival, which characterized the age when they lived. War, inflation, economic crisis, the collapse of the stock, the employment crisis represented all serious dangers for businesses in the last century. The first decade of this century does not represent an exception regarding the aforementioned threats list, the problem is that a further one was added – the loss of knowledge. The loss of knowledge due to the fact that the employees quit represents a threat – for the prosperity and productivity of the company – equal to the big threats of the last century.

This movement towards the knowledge lead to the significant increase of this one for the organization. Knowledge represents now the main economic production factor, an asset which has to be carefully kept and wisely used. But knowledge lay first in people's mind – people who leave the organization and take the knowledge with them. When knowledge gets out the door without leaving "children" the result can be devastating for the organization. The increase of losses can create a crisis for the organization. In fact, the organizations face currently such a crisis: retirements, transfers, abandons, resignations.

As long as the importance of knowledge increases the negative impact of the loss of knowledge at organizational level exponentially increases. The effects are predictable and expensive, including:

– reduced efficiency;
– decrease of productivity;
– increase of employees' stress and frustration;
– lower incomes.

All together these negative effects harm the profitability, the innovation capacity, the answer speed, reducing the chances of survival in front of the faster competitors and the more conscientious ones of this phenomenon.

Very suggestive to this purpose is the analogy carried out by Beazley et al. (2002), of businesses with long-distance race. The success does not belong to the sprinters who run alone. The long-distance race of businesses is formed by many sprints of a huge number of racers. For each employer – participating at the race as well as for the whole organization, each sprint takes place within a relay race, the success of the organization depending on its result. The competitive advantage in the Information Era belongs to the organization whose employees succeed in transmitting the know-how to the next racer who at his turn he will pass it on to the next one and so on and so forth in a succession that lasts as much as possible.

4. The continuum of knowledge

The knowledge being the basic resource is worth exploring its characteristics and how they can be used by the organization.

Simplifying, knowledge is represented by the set of skills that the employees must possess in order to carry out to an end their tasks in maximum efficiency and efficacy conditions.

Knowledge includes essential databases and information but it is broader than this. Knowledge is the base of the competence and wisdom which are more valuable for the organization than knowledge. The essential question for an organization which wants to conquer the knowledge-based economy is: how can the information be transformed in knowledge and further in competence and wisdom?

The continuum of the knowledge explains this process of conversion. Starting with the information and ending with wisdom the continuum has the following components (Beazley et al. 2002):

Data – Information-Knowledge-Competency – Wisdom

We cover these stages in an assembly of processes which bring a higher understanding, an increased ability to approach complexity, a holistic perspective.

Knowledge represents the information organized in a frame, concept, principles, theory, hypotheses or other action permits which increase the understanding of a situation and the probability to resolve a task knowledge allows action. According to professor O. Nicolescu (2005, p. 21), by **knowledge** we represent sets of information and skills by whose use it is generated an

added value. In conclusion, the essential distinction between the information – that which bring new elements – and knowledge consist in their capacity to create, by use, economic substance and added value, which interests mostly in economy. It can be plenty of information, usually far less knowledge.

Competency means knowledge integrated through own experience (contextual familiarity in the particular process that the organization exercises, eventually), which provides the capacity to resolve problems, to take decisions and to manage situations and tasks at a level that ensures success. In other words, competency means categories of knowledge assembled in an operational system, able to give solutions.

Wisdom – the most diffuse notion, usually easier to observe post-factum – competence refined by experience, practice, maturity brought in a judgment above the average, intuition, a holistic perspective, a level which allows correct decisions in complicated situations and instable environments, requiring a balance between the long term aims and the current needs.

5. Human resources management based on knowledge

Within this framework which has to be the mission and objectives of human resources management (HRM)? The measurement of the performances of the employees can not be done based on the algorithm of some "norms" imposed and recognized in the culture of a branch of production or another, as in the Industrial Era. Paradoxically, in an era of microprocessors, of top technologies, of equipments "independent" of man`s skills and attention, the human resource regains the hegemony among the economic variables of the organization. The responsible leadership and management of this resource represent the big challenge of the modern management.

In his classical work "Organization in action", James Thompson (1967) describes how the human variable affects the actions of the organisation. Later, Hambrick andi Mason (1984) stated that the organisations are reflections of their top managers. Based on this paper, Finkelstein and Hambrick (1996) underlined the importance of the human element in the strategic choice and performance of the company. The human resource increased its importance because the knowledge part became the critical ingredient in order to acquire the competitive advantage in the new economic landscape. In a recent allocution addressed to the Massachusetts Institute of Technology graduates, Carly Fiona, general manager at Hewlett – Packard, stressed this thing, saying that the magic ingredient, the most

important and tangible of the current landscape is the man. By follow, the answer to the key question of the strategic management: why does the companies performance vary, is that they differ from the point of view of the human capital (Hitt et al., 2001).

In the 21st century knowledge-based economy the employers have to cultivate their creativity of their people in order to be competitive. In "Human resource management in the knowledge economy", Mark Lengnick-Hall and Cynthia Lengnick-Hall (2003) state that since the manner in which businesses are done is modified, in the same measure the role of the human resources managers should be changed. Although many human resources classical activities are needed, they become more remote from the direct process of generating the value, state the two specialists aforementioned. The management of the human resources has to be torn apart from its bureaucratic past and to focus upon the "plugged-in" of the best brains.

In the knowledge-based economy the focus of HRM will not be restricted in its conventional form of recruitment, training, motivation and so on and so forth. The task of HRM within the knowledge-based economy also includes other activities which intersect with other traditional functions (finances, marketing, strategy) and other new ones (such as knowledge management). For this reason, HRM is not focused any longer on the leadership of the people in the conventional purpose. HRM is now responsible of leading the capacities created by people and the relationships that these people develop.

The adoption of the knowledge-based economy, of the construction and functioning of the knowledge-based companies can not be carried out without knowledge-based management. It has to be underlined the fact that the human factor has a decisive role in outlining the knowledge-based management as well as in outlining the company and the knowledge-based economy. Thus, the human resources become much more important and complex than in the previous systems. Consequently, the importance of the human resources management is increased at the same time with the substantial modification of its contents (Nicolescu and Nicolescu, 2005, p. 271).

The knowledge-based economy owes its conceptualization to philosopher Michael Polanyi (Price, 2004, p. 65). He considers the knowledge to have two faces: explicit and implicit. The explicit knowledge ist o be found in books, documentation, files and other accessible sources. The implicit or tacit knowledge is the one to be found in the employees' mind much more difficult to be accessed, for evident reasons. Usually, an organization does not know which this „knowledge" is. Even worse, the managers' trend to fire an employer when the least problem occurs means in fact to irresponsibly renouncing knowledge.

Grant (1997, quoted by Price 2004) argues that HRM can improve the competition of an organisation through the impact upon ”the knowledge basis” of a business: its employees’ skills and expertise. HRM can increase competition from a knowledge management perspective. A possible strategy consists in spreading the ”tacit” knowledge within the organisation and blocking its spreading outside it.

To this purpose, the organization should:

1. Accept that the set of knowledge is a vital source of added value for its products and services and a key for gaining the competitive advantage.

2. Clearly distinguish between the tacit and explicit knowledge.

3. Accept that the ”tacit” set remains within the individuals and it is learnt in an informal and not structured manner.

4. In a way or another, identify and record this tacit knowledge and incorporate it in the “structural capital” of the business in order to be able to be also transmitted to others.

The knowledge management supporters argue that the long term competitive advantage can be reached by identifying and recording the tacit knowledge. But the simple fact to agree with this principle based on the common sense ground does not tell us also how to do it. And many studies end here. A remarkable exception is Tiwana (1999, quoted by Price 2004), who points out:

”In the technology-based industry the companies which thrived are not the ones who invented new technologies but those which applied them. Microsoft is probable a good example of a company which first based itself on a good marketing then on the sale of shares and latest on innovation – mainly coming from exterior”.

Professor O. Nicolescu considers that a new productivity paradigm was outlined, pursuant to which within the new economy productivity means ”what, how much and how well it is produced by using the available resources with a view to increasing the clients’ satisfactions”. Knowledge, intellectual capital and time became the most relevant resources. Being the single resource which possesses the capacity to think and implement new ideas, people occupy the central position in the formulation of relevant productivity strategies.

The new type of human resources management outlined within the knowledge-based companies displays more characteristics by which it differentiates itself from the classical human resources management:

- The focus on the human resources approach from the perspective of the amplification and effectiveness of treating knowledge;
- The inclusion in its ranging sphere not of employers only but also of other main stakeholders of the organization;

- The intense differentiation or specialists' approaches, actions and behaviours in HRM field in order to be able effectively to consider the heterogeneity of the human resources involved in organization, of their characteristics, motivations and expectations;
- The performance in a participative manner, to the purpose of intense and direct involvement of knowledge-based specialists in carrying out the human resource activities which concern them, starting with the projection of their careers;
- The display of an intense creativity in all human resources management processes in order to be able to conceive adequate solutions for the different number of original elements involved in the efficient and effective use of human resources;
- Conceiving and performing the human resource activity in a flexible way, permanently modifying their functions and content, corresponding to the endogenous and the exogenous evolutions of the organisation;
- Keeping within the company the knowledge-based specialists, their elite, which became a central function of knowledge-based management on which the functionality and the company performances depend in a great measure;
- The subordination of all actions in the field of human resources to obtaining competitive economic performances and ensuring the company sustainability.

The mentioned characteristics reflect in all processes which represent the content of human resources management, leading to important modifications upon some of them.

6. Conclusions

Beginning with the times of the old, wealth and power were associated with the possession of physical resources. Wealth and power in the 21st century will mainly result from intangible intellectual resources from the knowledge capital.

The proliferation of new information and communication technologies, the changes in the role and functions of knowledge cause profound modifications in the way in which people work, learn, have fun and communicate.

As long as the mobility of information and globalization of employment increase, the knowledge and expertise can be instantaneously transported around the globe so that any advantage based on such differences

can disappear over the night. The only advantage that can be maintained is the one given by a continuous innovation process and by the creative talent of knowledge operators in order to manage a continuous flow of issues and challenges – the capacity to extract value from information.

We are now an information society in a knowledge-based economy where the knowledge management is essential and the human factor is decisive in outlining this type of management.

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RISK MANAGEMENT IN ECONOMY – FIRM PERFORMANCE

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Abstract: *There are many terms which describe from one or another perspective, a larger plane around the concept of rest, without being necessary valid the consensus on the differences of meaning between them: uncertainty, indetermination, ambiguity. The indetermination offers an image regarding the main limits of determining a phenomenon, the unpredictable objective character of it. The ambiguity refers to the inability of the subjects to determine clearly the significance of the situations where they will act. The uncertainty term is used to designate the limited ability of our knowledge, whether this limitation comes from indetermination for the approximate character of the information which exists at a certain moment.*

Keywords: risk, uncertainty, balance, quantification

1. Introduction

Risk management is the activity through which the management of the risks in an organization is done. The purpose of risk management is optimizing the exposure to risk. This way loss prevention can be obtained, avoiding serious threats and valuable opportunities can be exploited knowingly.

The balance between avoiding major risks and using opportunities is the "golden" key towards financial success. Risk management begins with risk analysis.

Risk analysis is an evaluation of risks which can affect the company. It begins with identifying the threats, meaning an inventory, as accurate as possible, of all the predictable threats. It is very important not to be overlooked any kind of threats, and for that reason is important using exhaustive control lists.

Once the threats are known, the probability of manifestation must be calculated (the occurrence) and the seriousness of the impact they could have on the organization. Because future events have a certain degree of

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uncertainty, estimating the probability of materialization is done with an error margin.

In businesses, most decisions are made in conditions of risk and uncertainty. From the investment in the shares of a stock exchange quoted firm to the decision to launch a new product or the construction of an ample project of infrastructure is necessary knowing the risk. It appeared and developed – most of all in the last decade – an analysis system, meant to help managers in process of making decisions, to lead to the consolidation of a risk industry. In the academic plane the theoretic fundaments which are at the base of this evolution determined the forming of interdisciplinary branches – the risk management.

The analysis process of risk is not as new as the developing phenomenon of the risk industry in the last ten years. Its recent evolution is due to liberalizing trade (the appearance of a "global status") which facilitates the access to new markets (so new risks) especially the technological developments which eases the measuring of the risk. If globalization meant increasing the complexity of the risks, the technological revolution allowed their more efficient management.

Realizing the firm's objectives involves knowing and assuming multiple risks. The risk management process includes three phases: identifying risks, risk analysis and risk reaction. Identifying the risk is done through making up some control lists, organizing risks identifying meetings and analyzing the archived documents. Risk analysis uses methods such as: determining the expected value, Monte Carlo simulation when you and decision-making processes. The risk reaction includes measures and actions to reduce, eliminate or share risk.

2. The risk concept

There are many terms which describe from one or another perspective, a larger plane around the concept of rest, without being necessary valid the consensus on the differences of meaning between them: uncertainty, indetermination, ambiguity. The indetermination offers an image regarding the main limits of determining a phenomenon, the unpredictable objective character of it. The ambiguity refers to the inability of the subjects to determine clearly the significance of the situations where they will act. The uncertainty term is used to designate the limited ability of our knowledge, whether this limitation comes from indetermination for the approximate character of the information which exists at a certain moment.

We call risk the uncertainty associated to any result. The uncertainty can refer to the probability of appearance of an event or to the influence, the effect of an event in the case it takes place. The risk appears when:

- an event takes place by itself but its result is uncertain;
- the effect of an event is known but the appearance of the event is uncertain;
- both the event and its effect are uncertain.

The risk and be considered *the more or less aware assuming of the results of the made choice*. It doesn't refer to the frailty of the knowledge, but to the probability of success or failure of the action performed based on a decision. The risk can come from the indetermination (the inexistence of information) of the results of the action, or from the ambiguous character of the information we have at a given time.

From the perspective of an economic agent the risk is expressed through the number which shows the dispersion or the volatility of a certain average.

The Risk Waters Group[1], a subsidiary of the *JP Morgan*[2] *Company*, defines risk management as the control and delimitation of risks on organization is confronted with following the exposures to the variable exchanges on the market.

Innovative facial documents of the Basel Committee is considered that the situations leading to risk exposure of an organization can appear due to the financial impact of one of the market variables (the market risk), due to the fact that the organization is not ready to respond to such threats (the operational risk), because of the payments inability of a partner (credit risk) or following the fact that a certain contract is not valid (legal risk).

Risk management is a cyclic process, with many distinct phases: identifying the risk, risk analysis and risk reaction.

If we will observe all the development initiatives of a risk discipline we can say that, generally, through risk management is followed the construction of an apparatus to permit first of all the identification and the quantification of risks in order to, according to the attitude towards risk, make a decision regarding the ignoring, the assuming or avoiding of them in the future.

The identification depends a lot on the informational system. The quality of the information the company has can be improved by increasing research expenses (for example, a researcher regarding finding out the probable market share of a certain products in a certain geographical area).

[1] www.riskwaters.com
[2] www.jpmorgan.com

The identification of risks must be done regularly. This has to take into consideration both internal and external risks. Internal rest are those the managerial team can control or influence, well external risks are and not under its control. In the same time, the money spent to obtain more information is added to the total expenses. The risk concept is closely linked to the probability logic. We can say that they refer to the controlled indetermination by objective probabilities: *the risk of the dice I throw to show one is 1/6*. In the conditions when, the probabilities attributed are subjective, the risk refers to a combination of objective probabilities and their subjective estimations. That is the case of the probabilities working with meteorology: they express both the indetermination and the limits of our actual knowledge; action directions. As following, it is important the appreciation of the need for a perfect information reported to the costs for obtaining that information.

The rest can be identified using different methods:

- making up some control lists which include potential risk sources such as: environmental conditions, expected results, personnel, objectives modifications, projecting and execution errors and omissions, costs estimations and execution terms etc.;
- the analysis of available documents in the archive of the form to identify the problems which occurred in similar situations to the current ones;
- using the experience of the directly productive personnel (the divisions end teams chiefs) by inviting them to a formal risks identifications meeting. Many times people on the field are aware of the risks and problems those in the offices don't notice. And efficient communication between fields and offices is one of the best sources of identifying and reducing risks;
- identifying the exterior imposed risks (through legislation, changes in the economy, technology, syndicate relationships) by assigning a person to participate to the professional associations meetings, conferences and to read specialty publications.

The quantification involves using some mathematical instruments (quantitative methods) and most of all developing some interpreting aptitudes for the results obtained in this way. The risk analysis process involves the probability calculation which raises the issue of economic prediction.

The economic prediction is a branch of economy which has as an object the anticipation of the economic phenomena. The companies are forced to make predictions of the market conditions when the production

plan issue is raised. The governments realize prognosis when they decide the budgetary or monetary politics. According to the one making the projection and the nature of the methods used these very from simple extrapolations based on past events to the prognosis for simulations for the entire economy. Both at a micro and macro level the predictions involve the construction of mathematical models.

3. The decision in conditions of uncertainty

Incorporating the risk in the economic theory to place relatively late – many of the first economists were statisticians (for example Francis Y. Edgeworth[3] and John Maynard Keynes[4]), and the concept of marginal utility, the fundament neoclassical economists was developed for the first time by Daniel Bernoulli[5] (1738).

The most important challenge in the beginning of the twentieth century was that of defining precisely the effect of the risk or uncertainties on economical decisions.

The most important step was defining the distinction between risk and uncertainty by Frank H. Knight[6]. Knight's interpretation is that the *risk* refers to the situations where the decision maker can attribute probabilities to the possible events. On the contrary, the *uncertainty* refers to the situations where the aleatory character of the events cannot be expressed in probabilistic terms.

The opinions regarding the difference between risk and uncertainty determined ample theoretical debates without reaching any unanimous accepted results so far.

The explication given by Knight can help in categorizing the most important theories emitted later regarding the decision in risk or uncertainty conditions:

1. The theory of expected utility with objective probabilities – von Neumann-Morgenstern (1944)[7] is a risk theory;

2. The *state-preference* approach – Arrow (1953)[8] and Debreu (1959), which doesn't assume attributing the probabilities, is on uncertainty theory;

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3. The theory of expected utility with subjective probabilities – Savage (1954)[9] is situated somewhere in the middle.

One of the most important contributions of von Neumann and Morgenstern was a demonstration of the fact that if an agent prefers lotteries, then there is a utility function which attributes a utility to any existent lottery. This is the criteria agents build their preferences on.

The essence of the assumption of the expected utility of von Neumann and Morgenstern consists in concentrating the analysis on the preferences for distributions and after that, by deduction, developing the reason regarding the preferences for the possible results.

Kenneth J. Arrow (1953) and Gerard Debreu (1959) realized another "subjectivist" nature revolution by developing the concept of preferring state regarding the uncertainty. Although it is not necessary opposed to the assumption of the expected utility the approach of the preferring state does not involve the attribution of probabilities, whether objective or subjective, even if most of the time this could be useful.

4. The need for risk management for

From a purely academic point of view the interest manifested by the companies for risk management can be curious. The classical theory of the portfolio states that the investors can eliminate the specific risk other financial assets through diversification. For this reason specific risk exposure will not be rewarded on the market. The investors build portfolios of the free of risk assets and a mix of risky assets, the share between the two categories of titles being described according to the risk aversion. The conclusion would be that, from the perspective of creating value for the shareholders, the investors can achieve this through diversification.

Partly, the inherent risk of a business can be reduced by the investor through diversifying the portfolio the business (operational diversification). The diversifiable risk is close connected to the specific events or phenomena of a field of activity or of a given firm. This type of risk can be met under the name of firm-specific-risk, idiosyncratic risk or nonsystematic risk.

The distinction between the risk the investor is exposed to and that the firm is exposed to is important is specially in the case of direct foreign investments. Direct investments are category of the international investments which reflect the objective of a resident entity of a country (direct investor) to obtain permanent, good profits following an action performed

[9] Savage, L. J. (1954), *The Foundations of Statistics*. New York, NY: Wiley

in another country. A permanent profit implies the existence of long term relationship between the direct investor and the enterprise. A direct investment relationship is created when the foreign investor either holds 10% or more of the shares, either he holds the voting power in the enterprise he invested directly. Foreign direct investment represents the investments of nonresidents as capital inputs of cash or assets, including the loans given by nonresidents firms to their subsidiaries. Generally, the distinction between the performant projects and the non performant ones depends on the resources and on the abilities of the firm to assume them. What for a firm can be an exception is desirable for another. The enounced distinctions prove their utility in selecting methods to estimate and control risk.

• *Bankruptcy costs*. The reorganizing or interrupting the activity costs of a company will reduce the actual market value. This is why risk management can increase the value of the firm by reducing the bankruptcy probability.

• *Taxes*. Many taxing systems include different methods to carry the taxing advantages of past losses. Ceteris paribus, reducing the volatility of future incomes will lead to reducing the updated value of future payments and determines the increase of the firm's value.

• *The structure and the cost of the capital*. A major source of bankruptcy is the inability to honor debts. As such, the higher the owing rate is, the higher the company's risk. Through a risk management, the situation of a high owing rate which can allow a more aggressive expansion of the firm as long as this means of financing is not expensive is possible.

• *Compensating packages through capital participation*. Due to the participation to the activity of the firm the employees have an implicit exposure to the risk of the firm they work for. This is the reason for which, the higher the risk of the firm, the higher the compensations solicited by the actual and future employees. Appealing to risk reduction means can determine the reducing of personnel recruitment costs.

5. Risk management and firm performance

Taking into consideration the interest for the risk management manifested by the majority of the firms on the market, one can draw the conclusion that generally, appealing to risk management techniques can generate value. Analysis regarding the practices used by the mining companies in gold industry revealed the fact that the market price of the shares of these companies is less sensitive to the price changes on the gold market following risk management. Similar analysis have been performed

on a group of firms who started to use other techniques to reduce risk and the conclusion was that the market price of shares is less affected by the changes in the interest rates or currency exchange rate. Allayanis and Weston show that the firms exposed to currency risk which decide to cover that risk have a greater performance than the firms affected by this risk and don't use management means.

There are studies which have found that a reduction of the volatility of the financial flows of the company lead to reducing the capital cost and higher investments. In the same time a portfolio of firms which use the techniques of risk management register performances higher than the firms which don't resort to risk management.

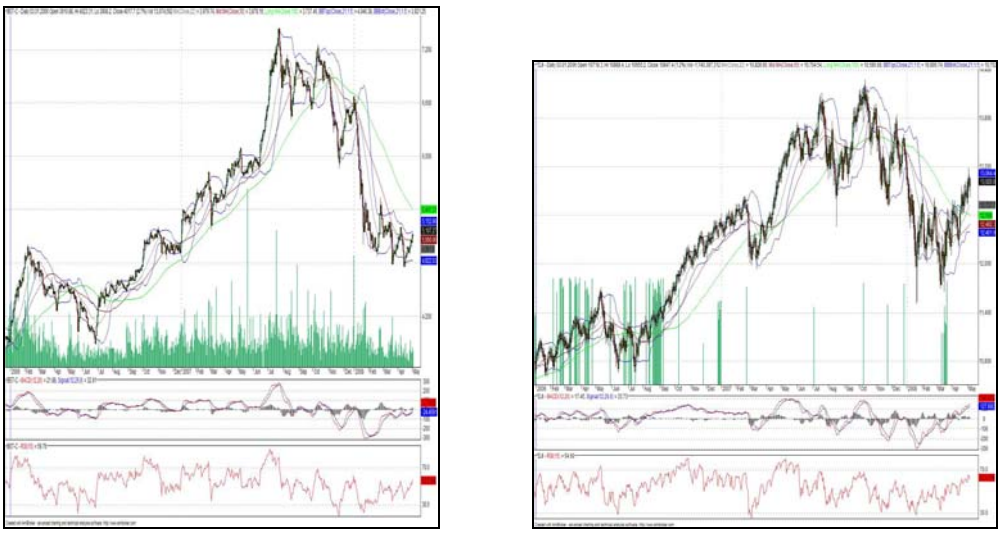
Although the empiric evidence reflect the necessity to resort to risk management techniques there are studies which show that, at a commercial banks' level, although the respect of the prudence principles led to the construction of a pretty conservative risk management system (large values of the amounts deposited as a minimum compulsory reserve to the central bank) there are many situations when the losses were higher than the predicted levels. The most usual situations the banks had to suffer from were determined by consecutive losses. If the first loss can be harder to predict, still the second one is possible to see with simple analysis methods. These reasons determined the development of some risk management means more advanced than the ones used at present.

6. The evaluation of financial risk in the light of the USA's crisis of sub prime loans

Based on these notions we tried to perform a study of some powerful American banks and of the ones listed at the Bucharest Stock Exchange.

In the attempt to get as many quantifiable data as possible from an extremely developed market, such as the USA, we looked for possible correlations with a country from an emerging market. It was said many times that Romania was strongly correlated to everything happening on the American financial market.

In 2008 alone, practically every media specialty article referred to the Dow Jones index (the most representative index of the American market). When it would fall, one could see the next day in Bucharest on the BET-C index (Romanian firms index) a perfect correlation, taken to extreme … at a decrease of 1% of the ^DJI (Dow Jones Index), the BET-C (Bet Composite) would drop with 3-4% and vice versa for increases (Fig. 1).



BET-C ^DJI

Figure 1. Comparison between BEC-C and DJI graphic evolutions.

But 2007 brought for the banking sector, and then obviously for the financial markets sector a great hit. The crisis of the sub prime loans, a crisis which has shaken from the grounds an economy so strong as the USA's and which then, with a domino effect, had side effects all over the world.

We wanted to see what was the effect of this crisis on the credits, on the financial indicators and on the market indicators of the first 3 banks of the USA (in the world's top 10 too). The study does not resume to the simple description of the American banks though, but also to that of the Romanian banks.

If the risk can be quantified so well by the American banks, we wonder if we in Romania can do the same thing. If we will start from the premises, that everything that moves on the American market, is directly sensed by our market, than let's keep checking the thoughtfulness of this assumption.

In the tables below (Tables 1 to 3) we presented the situation of the banks which will be in the study, taking into consideration the following indicators:

– Net income;

– Net profit;

– The profit generated by an action (Earning per share – EPS);

– The dividends offered (it is taken into consideration as a supplementary earning, except for the difference between the sales price and the acquisition price of a share);

– The prices registered by the stock exchange over a year (high, low, close);
– Stock exchange capitalization;
– ROA (the assets' return);
– ROE (the owned capitals return);
– Total assets.

Table 1

Financial and accounting data for Citigroup

Millions $ (except indices for shares)	Citigroup						
	2002	2003	2004	2005	2006	2007	2008 (Q1)
NET REVENUE	66.246	71.594	79.635	83.642	89.615	81.698	13.219
NET INCOME	15.276	17.853	17.046	24.589	21.538	3,617 *	-5.108
NET EPS (in $)	2,99	3,49	3,32	4,84	4	0,72	-1,02
CASH DIVIDENDS	0,7	1,1	1,6	1,76	1,96	1,28	0,81
MARKET SHARE PRICE (NYSE) ($)							
H	N/A	N/A	N/A	N/A	N/A	56,28	29,89
L	N/A	N/A	N/A	N/A	N/A	23,92	17,99
C	35,17	48,37	48,01	48,58	55,7	29,44	N/A
MARKET CAPITALIZATION	179.684	247.435	246.499	246.804	299.916	147.886	130.825
ROE (NET INCOME)	18,6%	19,8%	17%	22,3%	18,8%	-32,84%	-18,60%
ROA(NET INCOME)	N/A	N/A	N/A	N/A	N/A	-19,00%	-46,00%
TOTAL ASSETS	1.097.590	1.264.032	1.484.101	1.494.037	1.884.318	2.182.760	2.199.800

* In Q4 Net Income = -9,83B $; EPS = -1.99

Table 2

Financial and accounting data for Bank of America

Millions $ (except indices for shares)	BANK OF AMERICA						
	2002	2003	2004	2005	2006	2007	2008(Q1)
NET REVENUE	34.991	37.834	48.965	56.091	73.023	68.068	17.300
NET INCOME	9.553	10.762	13.947	16.465	21.133	14.982	10.290
NET EPS (in $)	3,14	3,62	3,71	4,10	4,66	3,35	0,23
CASH DIVIDENDS	1,22	1,44	1,7	1,9	2,12	2,4	0,64
MARKET SHARE PRICE (NYSE) ($)							
H	38,45	41,77	47,44	47,08	54,9	52,96	N/A
L	27,08	32,82	38,96	41,57	43,09	N/A	33,12
C	34,79	40,22	46,99	46,15	53,39	41,26	N/Y
MARKET CAPITALIZATION	104.418	115.926	190.174	184.586	238.081	183.723	167.520
ROE (NET INCOME)	19,96%	21,50%	16,47%	16,51%	16,27%	11,08%	0,66%
ROA(NET INCOME)	1,46%	1,44%	1,37%	1,32%	1,48%	0,94%	N/A
TOTAL ASSETS	653.732	749.104	1.044.631	1.269.892	1.459.737	1.715.746	1.740.000

Table 3

Financial and accounting data for JP Morgan Chase & Co.

Millions $ (except indices for shares)	JP MORGAN CHASE & CO						
	2002	2003	2004	2005	2006	2007	2008(Q1)
NET REVENUE	29.076	32.803	42.372	53.748	61.437	71.372	16.890
NET INCOME	1.663	6.719	4.466	8.483	14.444	15.365	2.373
NET EPS (in $)	0,8	3,24	1,55	2,38	4,04	4,38	0,68
CASH DIVIDENDS	1,36	1,36	1,36	1,36	1,36	1,48	0,38
MARKET SHARE PRICE (NYSE) ($)							
H	39,68	38,26	43,84	40,56	49	53,25	N/A
L	15,26	20,13	34,62	32,92	37,88	40,15	N/A
C	24	36,73	39,01	39,68	48,3	43,65	42,95
MARKET CAPITALIZATION	47.969	75.025	138.727	138.387	167.199	146.986	146.066
ROE (NET INCOME)	4%	16%	6%	8%	13%	13%	8%
ROA(NET INCOME)	0,23%	0,87%	0,46%	0,72%	1,10%	1,06%	0,61%
TOTAL ASSETS	758.800	770.912	1.157.248	1.198.942	1.351.520	1.562.147	1.684.862

One can observe that starting with the financial year 2007; the three banks recorded a drop of incomes and of the net profit. The exception seems to be JP Morgan, but here the effect of the crisis was felt only in the fourth trimester of 2007. The losses in this trimester were massive (billions), but are well disguised because of the extremely favorable situation of the first 3 trimesters. Only with the publishing of the results of the first trimester of 2008 we can observe the influence it had on them too. The incomes and the net profit dropped practically 5 to 6 times.

In the same time if we look over the tables we can see that American banks have an extremely stable policy when it comes to giving dividends. Each year dividends were given, even increasing ones, but for the first trimester of 2008 these dividends are the lowest of the last five years. If the results for the second trimester will be just as pessimist, there won't be any left by the end of 2008.

The returns (of the assets and of owned capitals) registered a serious drop also, fact reflected very well in the figure 2 with the average rental prices from the end of the last 5 years. (The prices are those registered by the New York Stock Exchange, the NYSE)

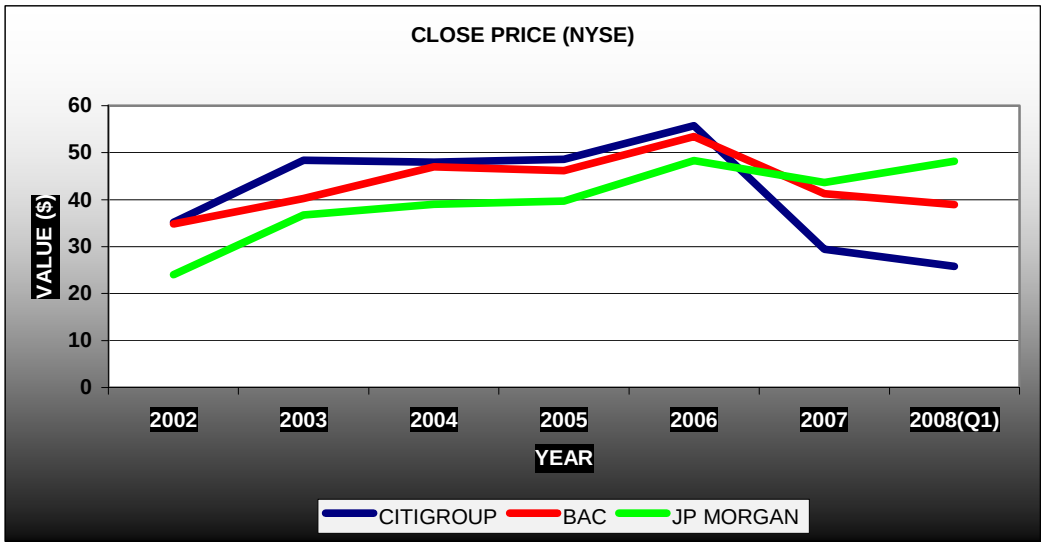


Figure 2.

Citigroup seems to be the most affected bank in the American sector, the closing prices in May 2008 growing under the minimum limits recorded at the end of 2002. Saving this bank appears to be in the hands of foreign investors, but it remains to be seen, after we will find out the data for the second trimester.

We will present the situations of the three banks with the help of figures 2 to 6, to be more suggestive from the perspective of results.

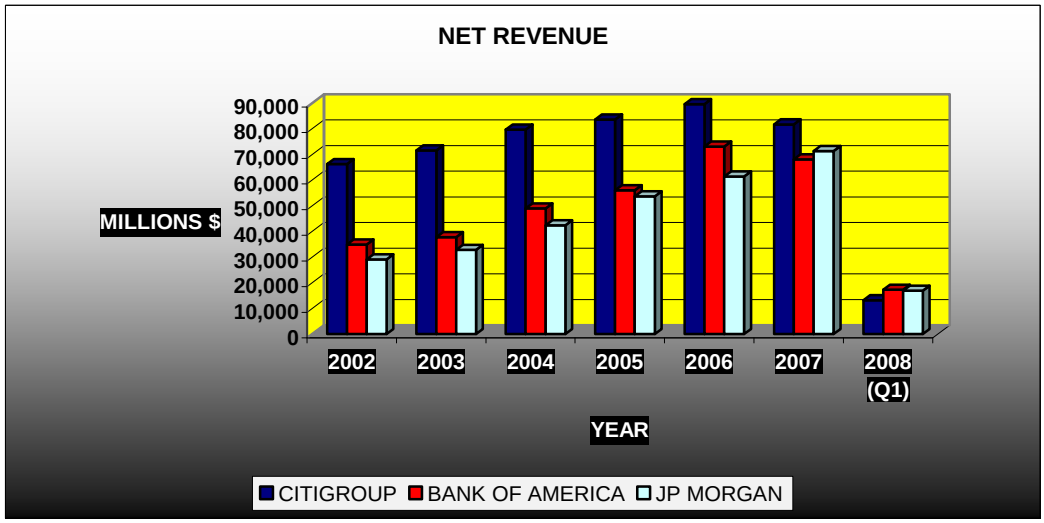


Figure 3.

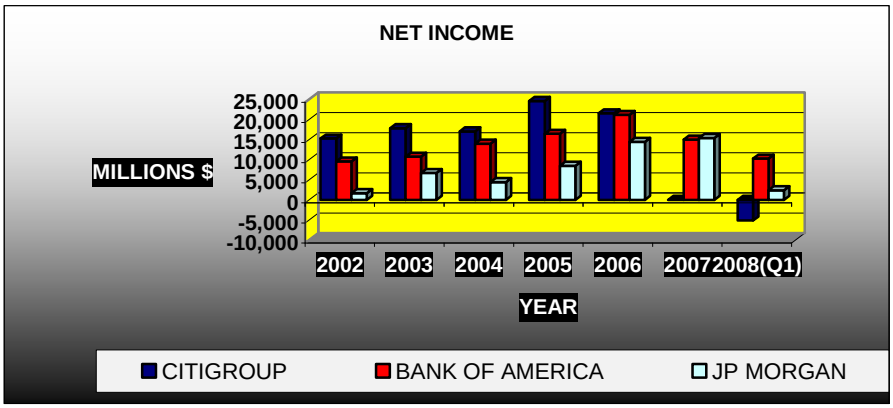


Figure 4.

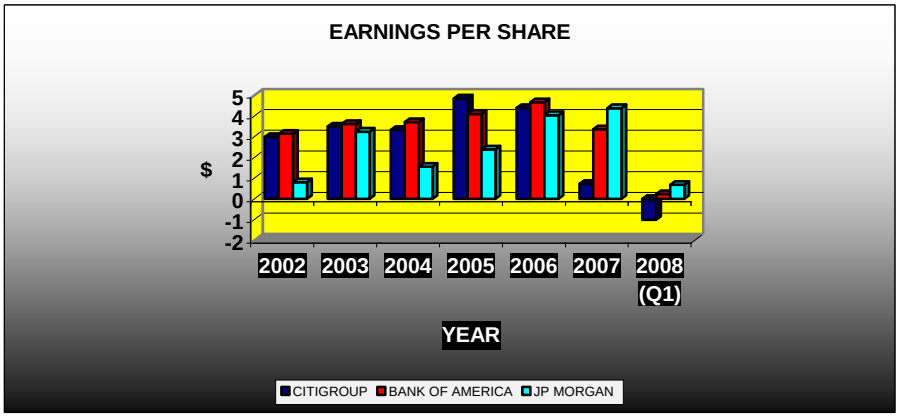


Figure 5.

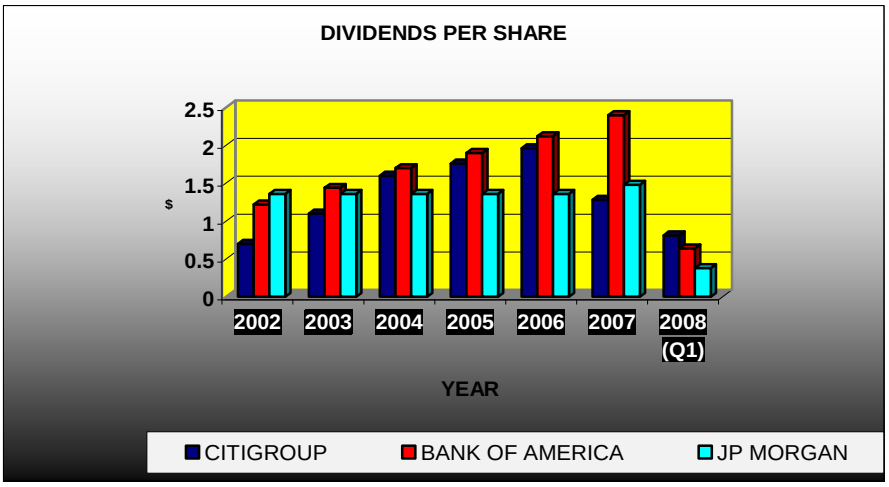


Figure 6.

Now that we have seen this data, let's try to analyze the assumptions for the Romanian banking system.

Unfortunately, up until now, not every data was published for the first trimester of 2008, but from the official statements of banks officials we can already make a general idea. 2008 started poorly for our banks too.

It's not the case to talk about loss. On the contrary, at the end of 2007, except for Transilvania Bank (the TLV symbol at the Bucharest Stock Exchange), which registered a drop of incomes; the other banks closed the year on growth.

If we look over all the data we notice that the correlation we are looking for with the American banks … exists but is very weak.

We cannot safely say even that these losses are caused by the same reasons.

2007 was an extremely difficult year for the Romanian banking sector. Being the first year after adhering, the competition became fierce, the number of banks grew, the diversification of products also grew. Aiming towards breach sectors was the main purpose of all the foreign banks which entered the Romanian market.

We will probably know more after the data will be completely publicshed and especially after we will have all the reports for the second trimester.

But the only indicator which was fully correlated with the American banking market was the prices from the stock exchange. These prices went in the same direction with that of the general market index BET-C.

But even for this there is a simple explication: most of the money on the Romanian financial market comes from direct foreign investments; when the American market, closely follower by the Asian one and later on by the European one started to drop…almost all that money exited our market.

It is well known the concept of investing on Eastern European markets (markets considered mainly emergent) which is: when entering, one enters all markets at once, and when they become overheated (new historical maximums are reached) they start charging profits. Meaning it is sold massively on all the markets at once.

On the Romanian market this was sensed more powerful, the most successful sectors being exactly the banking and financial ones (SIFs).

So these price drops don't actually reflect in 2008 the real accounting situations. We can place the blame for these drops on the speculative moves generated by the foreign investors.

As a curiosity, in 2008 the BET-C had the biggest drop of all the European indexes.

The chart is expressed by a logarithmic scale, being difficult to compare the BRD prices with the other two banks which have sub unitary prices.

Nevertheless one can observe that for the Transilvania Bank (TLV) and for Carpatica Bank (BCC) May 2008 slowly leads to values under those of 2002.

Even BRD registers severe drops (from a maximum of 30 RONs to almost 17 RONs), but is a little faded on the chart because of the logarithmic state (Fig. 7).

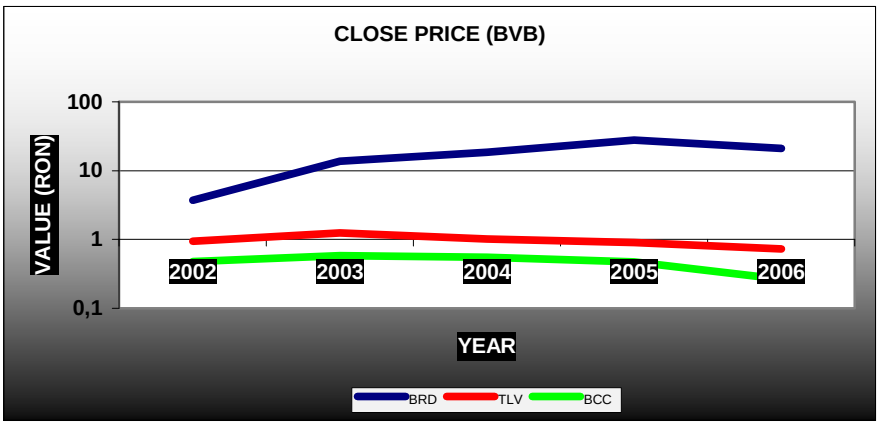


Figure 7.

Following we present the indicators for the Romanian banks and the afferent charts (tables 4-6 and Figs 8 to 11).

Table 4

Financial and accounting data for BRD

Millions $ (except indices for shares)	BRD						
	2002	2003	2004	2005	2006	2007	2008(Q1)
NET REVENUE	2.814	2.132	1.251	1.866	2.419	3,926	N/A
NET INCOME	98	103	157	241	286	400	17,5
NET EPS (in $)	N/A	0,1483	0,2269	0,3490	0,4104	0,574	N/A
CASH DIVIDENDS (in $)	0,0376	0,0302	0,0548	0,1132	0,1346	0,217	0,2583
MARKET SHARE PRICE (NYSE) (RON)							
H	N/A	N/A	3,78	15	20	30,1	27,6
L	N/A	N/A	2	3,66	14	18,6	17,3
C	N/A	N/A	3,73	13,7	18,5	28	21,1
MARKET CAPITALIZATION	N/A	1.178	2.268	4.144	5.624	8.513	6.415
ROE (NET INCOME)	N/A	N/A	23,90%	29,39%	28,12%	26,53%	N/A
ROA(NET INCOME)	N/A	N/A	3,07%	2,88%	2,34%	2,35%	N/A
TOTAL ASSETS	2.787	3.541	5.115	8.386	12.227	17.000	N/A
Apr 24 2008 1 USD = 0.4363 RON							

Table 5

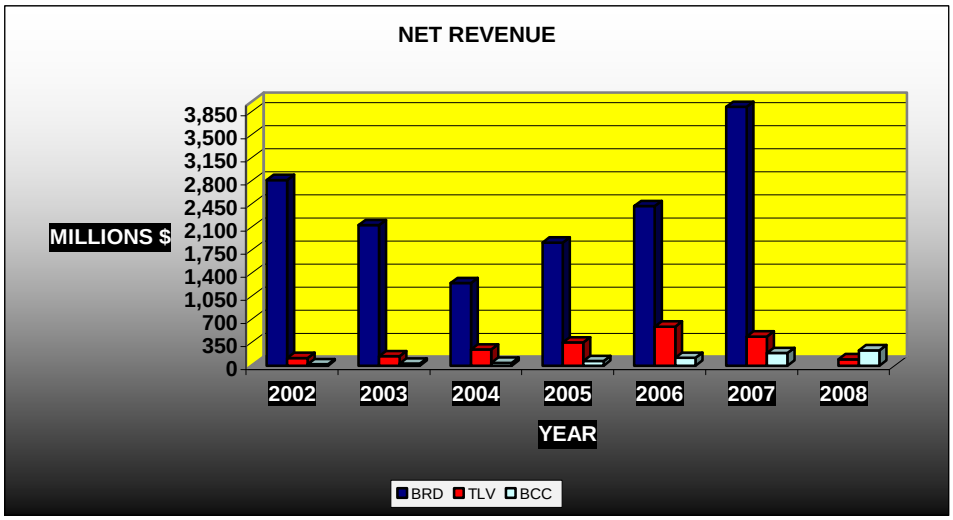
Financial and accounting data for Transilvania Bank

Millions $ (except indices for shares)	TLV						
	2002	2003	2004	2005	2006	2007	2008(Q1)
NET REVENUE	116	143	244	353	592	443	97,5
NET INCOME	19,3	20,4	26,5	43,5	52,4	148,3	26,3
NET EPS (in $)		0,021	0,0199	0,0184	0,0134	0,0243	0,0214
CASH DIVIDENDS*	0	0	0	0	0	0	0
MARKET SHARE PRICE (NYSE) (RON)							
H	N/A	N/A	0,9500	1,5300	1,5100	1,1500	0,9100
L	N/A	N/A	0,4700	0,6650	0,8550	0,7100	0,6700
C	N/A	N/A	0,9450	1,2400	1,0100	0,9000	0,7300
MARKET CAPITALIZATION	N/A	N/A	550	1.280	1.730	2.399	1,945
ROE (NET INCOME)	N/A	N/A	20,16%	21,52%	17,12%	28,10%	N/A
ROA(NET INCOME)	N/A	N/A	2,34%	2,02%	1,49%	2,45%	N/A
TOTAL ASSETS	373	620	1.135	2.151	3.527	6.054	6.513
Apr 24 2008 1 USD = 0.4363 RON							
*Dividends were given through free shares (always)							

Table 6

Financial and accounting data for Carpatica Commercial Bank.

Millions $ (except indices for shares)	BCC						
	2002	2003	2004	2005	2006	2007	2008(Q1
NET REVENUE	20,2	30	44,2	70,5	119,2	191,9	234,0
NET INCOME	4,2	5,7	5,63	7,57	8,2	3,6	18,9
NET EPS (in $)	N/A	N/A	0,0062	0,0073	0,0059	0,0022	N/A
CASH DIVIDENDS*	0	0	0	0	0	0	0
MARKET SHARE PRICE (NYSE) (RON)							
H	N/A	N/A	0,9750	0,7250	0,6800	0,6450	0,4500
L	N/A	N/A	0,4120	0,4300	0,4650	0,3900	0,2360
C	N/A		0,4800	0,5800	0,5500	0,4740	0,2640
MARKET CAPITALIZATION	N/A	N/A	187	255	326,8	328,2	182,8
ROE (NET INCOME)	N/A	N/A	11,05%	12,93%	12,14%	4,15%	N/A
ROA(NET INCOME)	N/A	N/A	3,00%	1,93%	1,18%	0,37%	N/A
TOTAL ASSETS	73,6	121,7	188,1	393,6	697,1	974	N/A
Apr 24 2008 1 USD = 0.4363 RON							



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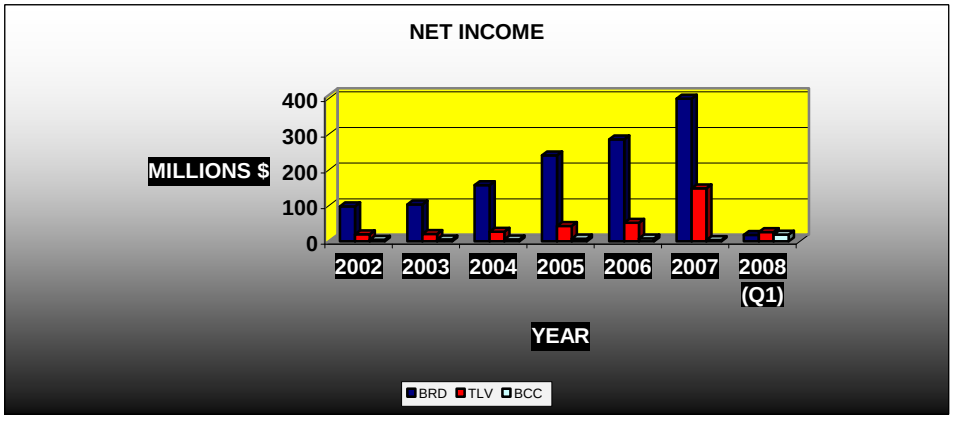

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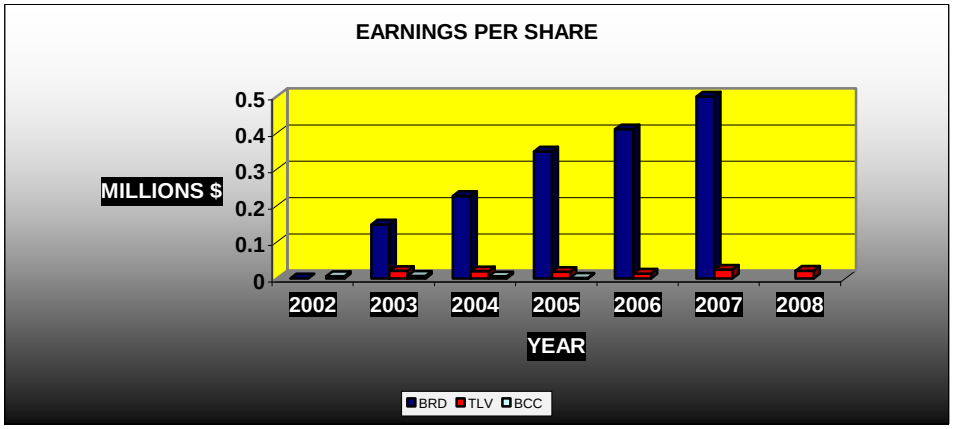

Figure 10.

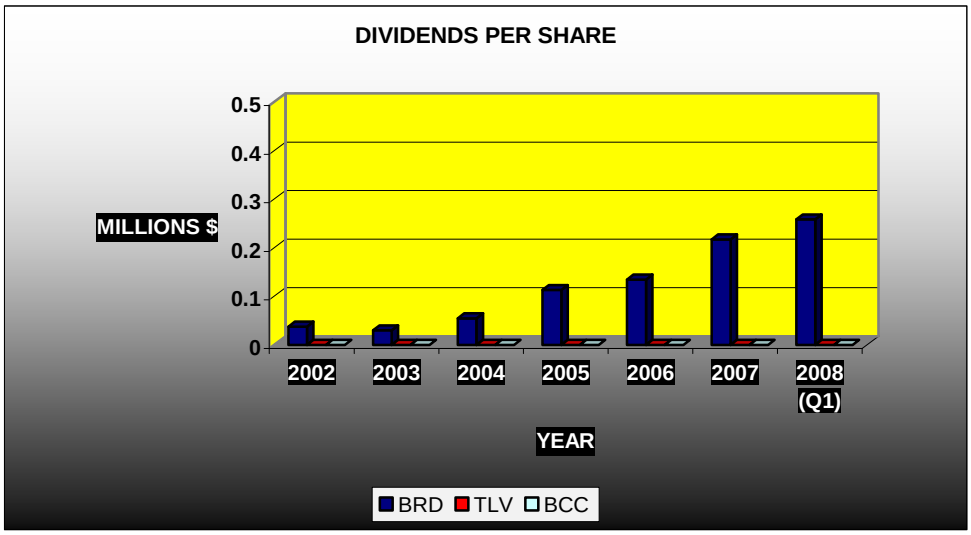

Figure 11.

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KNOWLEDGE, A STRATEGIC ASSET ABLE TO ENCOURAGE ROMANIA'S COMPETITIVENESS

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Abstract. *As concept-solution,* the knowledge society *represents the topic of a political, scientific, educational or media speech, able to create, by its concepts and impact, a new social reality. Information and knowledge regarded in their essence have always existed. The novelty is not the use of knowledge, because mankind has always depended on this aspect. The novelty is that Informational Society and Knowledge Society are capable to answer to the needs of the moment. At present, the society's conceptual-lization is recording a various range of approaches which, beyond a prior skepticism, reflects a systematic preoccupation for the operation of the respective concept. Thus, it is essential, on European level and on national level, to define the operation regarding the knowledge and research-inno-vation in a more complex society. Defining and understanding various actors actively involved in knowledge and the inter-connection between them within a consistent and durable environment are considered more and more key-elements. Considering knowledge as connected in different ways to the knowledge's object and social practice, the means to acquire knowledge and to make it institutional will make the comparative difference between the strength of the new society typology experienced by each nation. The preoccupations intended to make operational the* informational society *concept is mainly focused on the development of characteristic technologies and their strategies; for a change, making operation the concept of* know-ledge society *involves, by excellence, a systemic refection procedure in order to draft a visions necessary for a convergent action of the actions of the social actors involved. The aforementioned aspects suggest the fact that the* knowledge society *represents a typical example of dialectic concept, as the Romanian origin savant Nicholas Georgescu-Roegen defined together with the aritmo-morphic concept (Georgescu-Roegen, 1979). The notion of* knowledge society *is, due to its dialectic nature, a concept-problem and, at the same time, a concept-solution. As we can see, the* competitive environ-ment of the modern economic life represents a challenge for all organi-zations. *Success* in this environment addresses *creativity, innovation and flexibility*. Given the super-complexity environment triggered by the know-ledge based economy and society, the expansion and development of capabilities and competences within an organization by learning is vital. The competent management of complexity and change represents real sources for the competitive advantage sustainable on long term for the organizations

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knowledge based. *That why we consider knowledge as a strategic asset able to encourage Romania's competitiveness.*

Keywords: knowledge society, informational society, competitiveness, creativity, innovation, competences.

1. Knowledge society – concept, evolution and perspectives by means of diversity on global level

"The development of a strong knowledge based economy cannot be performed without ensuring a high level of education, as the social cohesion cannot exist without tolerance and respect for other cultures. Continuous learning does not consider only the formal education and training systems, but the active citizen, social inclusion and personal development".

Viviane Reding, *The challenges of shaping Education and Cultural Policies, in Culture, Cultural Rights and Education in an Enlarged Europe, The Enlarged Europe Forum, Bruges, 20 November 2000*

In the economy of the human society, the limited existence of the resources for covering the needs trigger the rational, as genetic code to express the manifestation and appreciation of human behaviors, on individual and social-institutional level.

The origins of the expression – *knowledge society* – (or knowledge based) could be identified in the papers drafted in the 60s, independently by Fritz Machlup and Peter Drucker. The first one proposed the term *knowledge Industries* (Machlup, 1962), and the second one – knowledge *work* and *knowledge worker* (Drucker, 1969).

At present, the society's conceptualization is recording a various range of approaches which, beyond a prior skepticism, reflects a systematic preoccupation for the operation of the respective concept.

1.1. Notions *of "information" and "knowledge" – delimitation of notions and clarification of basic differences*

The notion of "**knowledge based society**" is the center of EU policies. Politicians have built in this field a consistent speech, but the differences regarding the construal and enforcement of the respective policies are proving more and more certain epistemological confusions. Such confusions represent a significant threat for the concept' implementation and for the development of certain practices and institutional structures which would not support the process.

Thus, it is essential, on European level and on national level, to define the operation regarding the knowledge and research-innovation in a more complex society. Defining and understanding various actors actively involved in knowledge and the inter-connection between them within a consistent and durable environment are considered more and more key-elements.

Cook and Brown (1999) identified the need to differentiate between *information* and *knowledge.*

Thus, *information* represents a stable system, which can be formalized and transported and, as effect, it can be accumulated and owned. Regardless of the fact that such information is explicit or implicit, owned collectively or individually, different research focused on it, are based on the "epistemology of owned elements".

Knowledge seen as continuous process of creating information is associated with action and is understood as part of the practical activity, based on epistemological effort defined as "epistemology of action". Studies focused on this topic also name it "knowledge in practice" (Lave & Wenger, 1991), "learning based on experiment" (Bruner, Salling, Olesen) or "distributive cognition" (Hutchins, 1996).

Cook and Brown suggest the reduction of the difference between the two types of epistemology, be considering the information as instrument triggering knowledge within different activities. They refer to certain types of information, their heuristic value and validity given the different types of activities.

Considering knowledge as connected in different ways to the knowledge's object and social practice, the means to acquire knowledge and to make it institutional will make the comparative difference between the strength of the new society typology experienced by each nation.

1.2. The evolution of the concept of knowledge society (or knowledge based)

Generally, the stands characterized by skepticism regarding the *knowledge society* concept originate in the fact that the human society has always been knowledge based and the new brought by contemporary society only refers to the electronic support of the communication process and how information is handled. Moreover, the use of synonyms of *information* and *knowledge* – by ignoring their different positions in the epistemic hierarchy – either renders relative the distinction between the informational society and the knowledge society or leads to the adoption of

hybrid wordings – with questionable epistemological validity – such as "knowledge and information society".

However, a closer look could show that the distinction mentioned is relevant from the perspective of the operational valences of the two concepts. Thus, the preoccupations intended to make operational the *informational society* concept is mainly focused on the development of characteristic technologies and their strategies; for a change, making operation the concept of *knowledge society* involves, by excellence, a systemic refection procedure in order to draft a visions necessary for a convergent action of the actions of the social actors involved.

The aforementioned aspects suggest the fact that the *knowledge society* represents a typical example of dialectic concept, as the Romanian origin savant Nicholas Georgescu-Roegen defined together with the aritmo-morphic concept. (Georgescu-Roegen, 1979).

The notion of *knowledge society* is, due to its dialectic nature, a concept-problem and, at the same time, at concept-solution.

The concept-problem nature refers to the fact that the reality mentioned by the notion of *knowledge society* is a significantly growing one, under crystallization, thus, hardly to comprise it synchronically; as the characteristics of this new type of society are found, on large scale, in the existence of more and more human communities, its refection in epistemological plan, by means of the respective concept, it is susceptible of permanent improvements and reconsiderations. Thus, the development of the knowledge society is based on an orientation focused on a certain visions and not, as the case of the informational society, on template-programs or guideline-programs, although such instruments remain applicable for the specific actions of the social actors involved in this process.

As concept-solution, *the knowledge society* represents the topic of a political, scientific, educational or media speech, able to create, by its concepts and impact, a new social reality. As Terhi Nokkala (2004) mentions "terms becomes important because they represent forms of political rationality and regimes of epistemological validity according to which certain activities are deemed to be legitimate or not, they indicating, thus, which courses of action are the rational and logic ones. The speech's power resides in its ability to pre-shape a certain social reality starting from the terms defining it, making the participants to represent it as such and acting accordingly".

The notion of *knowledge society* justifies the registration of the idea representation procedure and the one of action for its performance, on the coordinates of the systemic (constructivist) paradigm, as defined by Le Moigne and Morin (1999).

The principles of systemic are highly general and allow, unlike the ones of the positivist paradigm, dominant in the industrial age, a more profound understanding and, thus, a proper management of the problems raised by globalization and complexity, characteristic to the contemporary society.

Not to proceed systemically regarding the knowledge society issue would have harmful consequences socially and scientifically, determining the sever decrease of the efficiency of the collective and individual action, but also the waste of resources.

The epistemological referential of systemic, which offers specific answers to the question "How do we know?" has two complementary positions, namely the phenomenological one and the finalist one. (Eriksson, 1997).

The phenomenological position endorses the status of knowledge as report between the knowing topic and the reality subject to knowledge. This hypothesis involves:

– to assign a determinant and active role, not only a acknowledging one, to the knowing topic related to the reality subject to knowledge;

– to approach knowledge as process and not as object – the information which is only the result of such process; otherwise, the latter would be seen as stock, namely in a closed environment.

The finalist hypothesis of the constructivist paradigm focuses on the projective (purpose) nature of the knowledge. The project undertaken by the knowing subject guides the "production" act of the new knowledge and the way of assessing its validity; thus, from a constructivist perspective, the knowledge's validity resides not in the attribute of objective truth, impersonal and transient, as positivism says, but it is expressed by vertical pertinence verified in specific action contexts based on their enforcement.

According to the constructivist paradigm, there can be explained the current trend to pass from the "*normal science*" to the "*post-normal science*". (Funtowicz, Ravetz, 1993). The normal science drafts new information within specialized disciplines and which are proper for solving small or medium problem possibly highlighted in the conventional management; the post-normal science endorses the integration of the information in complex, trans-disciplinary structures, useful for solving significant problems, which could be identified in a systemic managerial procedure.

2. The resources of the knowledge society. "Value-human" close relation

The real problem of the knowledge based society is meta-knowledge. The reason for this statement, deems Prof. Dinu Marin, resides in the

performance of an actions routine to avoid an entropic risk: reinventing the wheel. Thus, the world must always come back to the need to phrase an asymptotic answer to the question: how do we favor development using knowledge more and more?

The global society reduces humankind to the natural condition of depending on its own lasting resource – innovative in terms of liberties – thinking, knowledge. In fact, it is a real come back of the world to itself, noticed as its global stage of existence, where the Renascent attempts to focus the society's characteristics on value-human are revived.

Which makes that any generic concept, such as the knowledge society, to imply adherence, beyond rational, as it happened with socialism and communism, is its quality to trigger conjectural developments with ideological ambitions. The premises' projection, beyond being subject to reporting everything to possible bench-marks, with the exact knowledge of own strengths, fails in utopia. Not few are the temptations to solve everything by globalization. This is not different from the way of burdening excessively the communism with abilities – the true cause of its surprising failure.

As any other society projection, the knowledge society is voluntarily accredited with higher expectations than it could satisfy. Even in the most perverted possible way, globalization is charged with supra-normative functions regarding its ability to solve the problems of the pre-global world, such as poverty, sub-development, etc.

Obviously, a trick less visible for novices is practiced: it is implemented the idea of the continuity of the world's ordering principle, the order imposed from the perspective of the stronger party, namely, as Caragiale put it, something is changed, but the essence stays the same.

The knowledge society will be the expression of the human creativity marked by the rules of the living systems (Prigogine, Stengers, 1997), and not of the functional systems with energy eaters' ineptitude or a *top down* reproducibility. In a direct way, the knowledge society is a lot more than instrumental, even if *World Wide Web,* so, the knowledge society cannot be, as aforementioned, a new wonderful world.

As the global society it substantiates, the knowledge society cannot be, respecting its essence, a utopia, even if it mentions a sacrifice worthy ideal.

Avoiding the insinuating the concern for global is not only necessary, but it has to be possible by making internal the specific of the society of knowledge. Even by complying with the limits of humanity to be progressive by itself providing, as historically proved that nature – including the human one – dost not make jumps.

3. The goals of the European Union regarding the implementation of the knowledge based economy

The competitive advantage in the knowledge based economy will not be limited to products or services, but it will be determined by the ability of people and institutions to continuously acquire new abilities and of the fastness in exploiting the cutting-edge information. Globalization, with its competitive pressure, transforms the constructing requirements of the knowledge based society into an urgent objective. In this context, the Meeting from Stockholm of the European Council has clearly reinforced the goals stipulated in Lisbon, which must be respected and implemented. The conclusions from Lisbon have clearly established the common strategic goal for all the countries of the European Union[1].

Thus, there have been identified the most sensitive levers to be used by each country in order to reach this objective goals. These are:

– to remodel the national educational system to ensure equal chances to acquire new abilities and competences during the entire professional life;

– to influence employers to increase the level of competences, skills and abilities of the employees;

– to create a stimulating environment related to the innovation and development of the entrepreneurship initiative;

– to update the government structures for the online age;

It is important to notice that the successful implementation of the *knowledge based economy* means more than new competences, abilities and skills. Each employee must prove more entrepreneurship initiative, both as employee and citizen. There are mainly endorsed business initiative, but are equally supported and the development of creativity, innovation, flexibility, team-work and any form of discovery arising from intellectual curiosity. More and more, individuals must be able to undertake responsibility for their professional path. Given that employment throughout the active life will not be certitude, each active person must identify the employment opportunities and to be come interested in acquiring the competences necessary for permanent training.

4. The need to pass to the society of knowledge

The society based on information and knowledge implies the intensive use of the information for all activities and human existence, with significant economic and social impact.

4.1. The main characteristics of the knowledge society

The new technologies of information and communication are used both on individual level and within highly flexible organizations, arising from the independence of the human activity related to space and time.

Thus, an accurate implementation of the knowledge society implies the convergence of three key-elements: information technology, communication technology and multimedia production.

• Description of the knowledge society

The fast development of the information and communication technology within the past years has had an increasing impact upon society and global economy, highlighting fundamental changes of the production and distribution patterns, trading conditions, employment and daily life. At the beginning of the new millennium, global economy is experiencing the passage from a significantly industrial society to a new set of rules – the society of knowledge, which leads to the occurrence of what is called the new economy.

The reasons of the passage to the knowledge society are dictated by the powerful dynamic of the new economy, where digital technologies render easier and cheaper the accessing, processing, storage and communication of information. This huge volume of available information creates exploitation opportunities by creating new products and service, by developping new activities and increasing the employments. The new economy, characteristic to the society of knowledge, transforms digital information in economic and social value, creating new industries, adjusting the existing ones and profoundly affecting the life of all citizens. Also, the reasons of the passage to the knowledge society reside in its characteristics, which are expressed from several perspectives, from global to individual:

– *politically*, the knowledge society is a democratic one;

– *administratively*, it offers development possibilities for business and public administration;

– *socially*, it offers people easy access to education by developing the informational and communication infrastructure;

– *legally*, it adjusts the labor's nature, creating conditions for the performance of activities specific to the informational age;

– *economically*, it triggers the increase of the business potential and labor productivity;

– *culturally*, it is a society knowledge based, ensuring the recognition of the human values (tradition, religion, inter-human relations etc);

– *individually*, it allows the capitalization of intelligence with small investments;

• **Change of the labor's characteristic**

Another reason for the passage to the knowledge society is the change of the labor and organizations' nature, which develop together with the society and represents the main evolution mechanism. The labor object is no longer dependent only on a certain field, work implying information, at the same time. Thus, it is necessary to carry out activities such as collection, processing, memorizing, adjustment, request and change of information.

4.2. The entrance in the "Age of Responsibility" triggered by the new knowledge society

Amartya Sen deems that "people themselves must be responsible for the development and change of the world they live in. You do not have to believe or disbelieve to accept this basic connection. As people leaving together – broadly speaking – we cannot run from the thought that terrible events around us are, in their essence, our problems. They are our responsibility – even though they are others' responsibility". (Amartya Sen, 2004).

The transition to a New Society is as necessary as Amartya Sen says "development needs to fend off major sources which lead to liberty privations: poverty as tyranny, low number of economic opportunities and systemic social privation, neglect of public facilities and intolerance and over-implication of the repressive governments (Amartya Sen, 2004). Despite of unprecedented increases of the general wealth, the contemporary world denies the elemental liberties of a high number of people, maybe of the most.

The new age we have to enter is one of a fecund concordance of the world's contraries where we all live a unique spiritual experience, based on the "balance between freedom and responsibility, property and equity, pleasure and limitation; the connection between justice and love, rational and affective; the alliance between science and morals; the accommodation of technique with nature (*Enciclopedie de Filosofie si Stiinte umane,* Editura AII Educational, Bucuresti, 2004, p. 1039)

5. The „3I" of the knowledge society – brief presentation

The „3I" of the knowledge society (Dragomirescu, 2001) symbolize the triad of the processes which may be deemed significant for this society's phenomenology, namely: innovation, learning and partnership inter-activity. They are self implied and influenced and, understood as an organic whole, highlight the essence of the new society (Drucker, 2001), having a special significance for the present and future of Europe (Langer, 2000).

Within the examined triad, innovation – which, in this project, is considered to include both the *invention* type outcomes and the *innovation* ones – address the generation and development processes of the new ideas, while learning corresponds to the absorption of the information communicated/transmitted by changes of mental and behavioral patterns, within the plan of effective actions; as articulation factor, the partnership interaction intervenes in the relations between the actors – individual or collective – of the knowledge based activities within organizations, communities and society. It can be concluded that the "3I" are articulated in a "spiral" of knowledge – that dynamic of generations of ideas and solutions, continuous and self-maintained, which fits in "virtuous circles" processes of their generation, communication and use in action.

In the Europe of knowledge, the innovation issue is approached mainly from the perspective of the relation between the national innovation potentials and the refection of the innovation in terms of competition, both on the level of institutions and national economy; the *innovation* factor intervenes explicitly in the patterns of policies regarding the performance of the economic convergence, both between the groups of member states with different development levels and in the economy of the European Union enlarged related to the other poles of development from the global economy. It is worth mentioning the experience of Scandinavian countries regarding the innovation oriented policies. Thus, the triple helix pattern adopted by VINNOVA, the Swedish agency for innovation, wants to offer, based on incremental approaches, efficient solutions for issues regarding the drafting, communication and use of new knowledge elements (Etzkowitz, 2002). The phrase chosen to name this pattern represents suggestively the symbolic interaction established between three actors, namely the ones in the research field, business field and political filed. The first class comprises researchers (who are busy using the knowledge elements they obtain or create) and professors (who begin their classes in order to convey the new knowledge, preparing grounds to form advanced skills for graduates). The second class comprises entrepreneurs, who are aware of the economic value of the new knowledge elements, managers, who anticipate the market demands undertaking opportunities and risks for the enforcement of the conceptual and technological solutions, and investors, who engage in new projects, who wait for the consequences of the investments performed to obtain new knowledge elements. The third class includes politicians, who allot public funds for research-development, legislators, who influence the functioning conditions of companies, research centers and universities and local public authorities, which facilitate the establishment of new companies and help to the creation of an attractive life and work environment. (Filip, 2005).

A new approach, in the same context, addresses the relations between product innovation and process innovation and how their articulation influences the positions of each country in the global hierarchy regarding the performance of the national innovation systems; thus, the economy of the European Union may be characterized as focused on the process innovation while the North-American one – on the product innovation.

The modern partnership forms, *cluster* type, which comprise institutions, research centers, universities and public administration institutions, are likely to stimulate the innovation associated with productivity increases, which generate new employments, given the endogen economic increase. They supplement the previous paradigms of the expended enterprise, virtual or "net-worked." (Filip, Barbat, 1999).

The advance of the knowledge society grants new valences to the learning process, improving it in terms of manifestations and implications.

Individual learning is present everywhere an organized human activity is performed; it arises from the permanent confrontation between goals and means, expectations and outcomes, aspirations and environmental conditions where the action is performed. In terms of its organizational and collective dimensions, learning occurs naturally even only for the communication and present collaboration in any community.

6. The issue regarding the knowledge society in Romania. European context reflections

The expansion of the European Union is carried out in a tight interconditioning with the reform of economy and its institutions and with the advance of the society of knowledge. It can be said that the phrase "Europe of knowledge" synthesizes the essence of such major evolutions, different in meaning, but convergent in meaning and horizon; it express a way of thinking and an undertaking to act for a future based on aspirations and common values, partnership for the development of science, technology and economy, the assessment of the European citizen status.

In 2006 there will be 12 years since the launching of the document named "Europe and global informational society", known as the "Bangemann Report", as presentation of the role and contribution of Martin Bangemann, the then-vice-president of the European Commission. (Bangemann et al., 1994). This document drafted by 20 personalities of science, politics and business, was passed at the meeting of the presidents and governors in Corfu and represented a first significant impulse towards the awareness and European systematic action on large scale for the informational society.

In June, 2002, the European Council from Seville adopted the Action Plan „e-Europe 2005 – An informational society for everybody" (Council of European Union, 2003). The deadline of the enforcement of the Action Plan "e-Europe 2005" coincides with the review of the Strategy from Lisbon where it was established the goal for the European Union to become, until 2010, "the most competitive and dynamic economy knowledge based, able to support economic growth, with more and better employments and a higher social cohesion" (Lisbon European Council, 2000). Starting from this reviewed strategy (Commission of the European Communities, 2005 a), which focuses on the economic growth and the superior use of manpower and the acknowledgement that in Europe; the informational society has passed from the "testing-stage" to the "large expansion" one. The European Commission has launched the "2010 Initiative (Commission of the European Communities, 2005 b), a five year strategy intended to lead to the developpment of the Europe of knowledge based on the new TIC generations.

Regarding Romania, it could be deemed that the progress to be registered in terms of knowledge society would condition, directly, the rhythm and quality of its European accession, long and complex process, engaging the efforts of the entire Romanian society.

7. Conclusions

The competitive environment of the modern economic life represents a challenge for all organizations. Success in this environment addresses creativity, innovation and flexibility. Given the super-complexity environment triggered by the knowledge based economy and society, the expansion and development of capabilities and competences within an organization by learning is vital. The competent management of complexity and change represents real sources for the competitive advantage sustainable on long term for the organizations knowledge based.

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THE IMPACT OF CREATIVITY MANAGEMENT ON ORGANIZATIONAL PERFORMANCES

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Abstract: *Inserted in the context of "The New Economy" the mission of this paper is to investigate how organizational creativity is managed. The paper is based not only on my personal research, but also on a real study case about one of the biggest Portuguese companies – EFACEC. The first section will include some theoretical aspects about managing creativity and its impact on organizational performance; how some experts define createvity and what factors and practices stimulate and enhance creativity. I will then give a brief description of the EFAinova project (part of the EFACEC creativity and innovation system) which occurred in 2003 and was a sort of turning point for the organization in regards to its management of creativity. I will continue my paper with the case study sections that resulted after conducted empirical research in EFACEC. I divided this part into three subsections: the Workshops Strategy – how they are organized and who participates; the innovation culture – information about the innovation culture and the main characteristics of a creative person; and the Innovation Cabinet – how it runs, its functions and purpose. I will conclude the paper with my own theory about creativity and a few discussion points about the findings at EFACEC.*

Keywords: Innovation, Knowledge, Organizational Learning, Creativity

1. Introduction

In today's modern markets, manufacturing companies face severe competition from numerous local and foreign firms because of globalization processes. Thus rivalry of the particular company is tightly dependent on the competitive advantages of the firm. According to Wheelihan K, innovation and creativity is the vital key for being successful in a rapidly changing environment. It causes development of new technologies, products, and managerial practices, thus allowing the company to attain a leading position in a particular niche and/or maintain competitive advantages over other companies.

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2. Managing creativity in theory

The notion of creativity and innovation is perceived as a major influence for organisational success and as such a major issue of concern for managers. "Innovation can arise from several main sources. It can originate from individuals, research efforts of universities, government laboratories and incubators, or non-profit organisations. A primary engine of innovation is firms, because they have greater resources than individuals and a management system to marshal those resources towards a collective purpose"[2].

The role of creativity is underlying for the generation of novel and useful ideas. If creativity is mainly realised for creating competitive advantage, then much closer attention needs to be paid to understanding how creativity exists as an array of contextual and unique company resources and relationships, not simply as a commodity which can be acquired in the marketplace.

In the specialised literature there are quite a few theories that deal with the term of creativity: definitions, role of creativity inside the organisation, ways of managing creativity, but none of these give for certain their findings.

Creativity is often seen as a psychological phenomenon, an aspect of behaviour, "the act of doing something new"[3].

Maybe the most common definition is the one that states that creativity is "a mental process involving the generation of new ideas or concepts, or new associations between existing ideas or concepts".

George Keller said that "creativity consists largely of re-arranging what we know in order to find out what we don't know".

In today's business environment it is very important that organizations have the ability to be creative and innovative in order to gain competitive advantage and thus stay active in the market.

"The CITF (Creativity Industry Task Force) defines creative industries as: those industries which have their origin in individual creativity, skill and talent and which have a potential for wealth job creation through the generation and exploitation of intellectual property"[4].

The creative work process depends mainly on the interaction of relatively autonomous employees, which determine the management process, rather than vice versa.

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[1] M. Schilling, *Strategic Management of Technological Innovation*, 2005, McGraw-Hill

[2] www.mindtools.com/pages/main/new MN_CT.htm

[3] *Managing creativity and competitive advantage in SMEs: Examining creative, new media firms* by Banks, M; Elliot, M; Owen, J.

"Creative people work for the love of a challenge. They crave the feeling of accomplishment that comes from cracking a riddle, be it technological, artistic, social or logistical."[5]

3. The EFACEC group

With a history of more than a century, EFACEC Group was formed in 1948, and became the largest Portuguese Group in the field of electricity and electronics.

Efacec Innovation – EFAINOVA Project

With the ever increasing notion that in today's global market western enterprises have only creativity and innovation as a comparative advantage, EFACEC realizes that a company which cannot innovate is condemned to decline. The EFAinova project began in March 2003. Carried out as a project from and for EFACEC, EFAinova is the result of the work of numerous EFACEC collaborators who joined efforts to "Think a new EFACEC". It was an initiative of the EFACEC administration and its President and therefore had their support from the beginning.

Challenges

Two topics were submitted as challenges of the project:

Improve and create value of the products and services, strengthening EFACEC Group synergies in the field of Energy;

EFACEC – "One of the Best Employers in Portugal"

Innovation workshops and laboratories

Innovation Workshops and Laboratories were held in order to analyze EFACEC businesses as well as to delineate new potential opportunities, with the involvement of more than 200 collaborators, with different experiences and representing all Group Business Units. These innovation workshops and laboratories surpassed all expectations due to the zeal and interest demonstrated by the internal participants and additional contribution of different external entities, especially interviews with clients and study visits carried out within the scope of this project.

[4] *Managing Creativity* by Richard Florida and Jim Goodnight – from Harvard Business Review

Furthermore directors and managers from important clients such as EDP and BRISA were invited to participate in project. This permitted EFACEC to be closer to its clients' needs and strengthen relationships.

Methodology

Assuming that Innovation must be seen as a systematic, continuous and sustained procedure, the team formed to manage the pilot project within the Group developed its activity into three fundamental directions: Contents, Learning and Behavior. The workshops involved the discussion of new perspectives and then structured brainstorming sessions.

The following list summarizes the results of the project:

– 21 workshops involving 140 collaborators along with collaborators from EDP
– 10 internal and external interviews
– 3 study visits
– New perspectives
  - 90 Orthodoxies
  - 8 Core competencies
  - 71 Client necessities
  - 62 Discontinuities
– 16 Laboratories of Innovation
– 500 ideas generated
– 48 potential opportunities.

Of interest to creativity are the 500 ideas that were generated during the structured workshops which led to 48 potential opportunities. EFACEC was able to create the adequate atmosphere that encouraged and enhanced collaborators to participate and contribute positively.

Achievements of the project

The EFAinova project turned out to be a huge success and brought a multitude of advantages to the group. It permitted a wider and deeper knowledge of the whole group, enabled a new experience for team work, demonstrated the groups' capacity to generate ideas, and established the premise that everyone's contribution is needed. Furthermore, it was acknowledged that the exchange of ideas and communication amongst the collaborators from different levels and departments is of vital importance.

In conclusion the EFAinova project brought motivation, strength, and enlightening teamwork spirit to the collaborators at EFACEC. The fact that so much creativity was stored amongst the colleagues and that it just

needed to be unleashed was satisfying. Moreover, it set the foundation work for the establishment of the Innovation Cabinet at EFACEC.

4. Creativity at EFACEC

At EFACEC everyone is expected to be creative in their day to day work. In the past there were two well defined groups: the lower rank workers who were limited to following and fulfilling orders, and a higher rank that was paid to "think". Today every person in the context of their functions is responsible to making suggestions to improve, to innovate; in other words put to their creativity in practice.

A key issue then is how EFACEC motivates its workforce to be creative. It turns out that creativity is a crucial aspect of the organizational culture at EFACEC. The people feel that their ideas are supported and encouraged to open dialogue with not only colleagues but also with superiors. Thus EFACEC defines creativity as being a mixture of individual skills and organizational capacity to facilitate the interaction of those individuals.

Successful organizations are those which have an "open spirit" for innovation. Innovation should be integrated as a continuous process, this implies human and financial investment, but most of all a positive attitude of all employees, of all stakeholders. Success comes from looking for the next opportunity and having the ability to find hidden connections and insights into new products or services desired by the customer.

All persons inside EFACEC must be creative, they have to feel motivated and feel that their ideas are taken into account. Whereas creativity is perhaps more directly concerned with generating ideas, innovation is more concerned with the actions and outputs of those ideas. When employees put forward their ideas they do not have the power in most cases to implement them. One of the functions of the Innovation Cabinet is precisely to follow through and act on employees' initiatives.

Presently through the Innovation Cabinet EFACEC has two main paths to manage creativity:

- The "Idea Program" consists of an intranet system that receives and diffuses new ideas from all the collaborators. This Program which is still in the implementation phase is based on a system that wants to gather all collaborators from all the departments inside EFACEC. Through this program their ideas will be recognised which is more important for employees than financial bonuses. They create honour panels for the persons who contribute with successful ideas.
- Workshops

4.1. Innovation culture

With the active support of management, innovation is presently at the order of the day. There is a reinforced collective awareness that it is permanently necessary to question the "status quo", thinking and acting against the trend is the only way to be Innovative and Innovator!

Implement, within the Group organization, an innovative culture creating Corporate Value to turn it the EFACEC Group Value adopted by any member of the organization, independently of his function, is the principal mission of this project. Generate and manage growth for tomorrow, is, obviously, an important challenge for all of us. The objective of the IC is to gather as many ideas as possible. They get in average 50 ideas and most of them are put into practice. First every idea is analysed by a jury which studies closely the cost-profit rapport. If for example the cost is smaller than the profit at the end of the year than this idea is put into practice. If it corresponds with the requirements of the project, if it is better than another one, every aspect is taken into consideration. During these workshops they get ideas about the environment, comfort, quality, communication.

In order to motivate people to be creative you have to have good communication processes and practices inside the company. Every time you get an idea from the collaborator you have to respond to that idea and give feedback. Also it is important not to loose time in analysing the idea.

Although different departments have different needs some similarities can be found; for example in energy, transport and robotics creativity can appear in different way but somehow linked.

4.2. What are the characteristics of a creative person in the opinion of EFACEC?

Usually the recruitment is made by persons from human resource management. A creative person should be dynamic, with broad horizons, with cultural background, with different experiences, and with new ideas.

The Innovation Cabinet has the objective to stimulate creativity. When persons are occupied with routine jobs, they are not really concerned with creativity; this is why the Innovation Cabinet has to stimulate them. The people have to reflect on the problems that are inside the organisation (workshops are used to identify problems). New employees have more ideas, the others enter in routine and they start not to question things, so they are not interested in creativity, in developing new ideas. Here is where the workshops intervene – because they try to offer an incentive for creativity.

The IC has autonomy in choosing and forming teams inside the workshops.

4.3. The Innovation Cabinet

The reason for creating the EFACEC Group Innovation Cabinet was basically to carry on from the success of the EFAinova project. Administration realized that the enterprise's greatest asset regarding creativity rested within the group. Thus the challenge was to develop a way to manage and direct the group's potential creativity. The cabinet is composed of three persons: two from Porto and one from Lisbon. They are inserted in the "Shared Services Department", are an autonomous transversal department supported by the unity of the group and the specific division which they grant services to.

The mission of the Cabinet is to develop a culture of innovation; innovation not just at the technological level but at all levels such as organizational, management, sales, and services, amongst others. The Cabinet has the task of creating an adequate environment in which creativity can flourish; teamwork and communication enhanced, and the network of relationships strengthened. This "creative environment" is strongly supported by Amabile (1988, 1997) who defends that in order to encourage creativity information and new ideas must be communicated openly between all levels. Moreover the Innovation Cabinet preoccupies itself with the coordination of workshops and events, and in finding ways to involve and stimulate all collaborators in order to contribute with ideas.

4.4. The Ideas Management Program

The Innovation Cabinet promotes creativity in two main ways. One way is through the "**ideas management program**" which consists of an intranet system that receives and diffuses new ideas from all collaborators. Up to now this program was available to half of the population at EFACEC, it is now being extended to enable every collaborator to contribute and stay informed with all news and developments at EFACEC. This program is effective in introducing innovative ways to improving processes. EFACEC believes that there is nobody that knows the job better than the workers themselves so they are encouraged to intervene with suggestions every day. This program produces on average **one good idea per week which is applied**.

Once an idea is received it is analyzed by a jury, who nominates someone to go to the site for further analysis. A feasibility analysis is performed to estimate if the benefits outweigh the costs; if they do then the idea is generally adopted. The Innovation Cabinet has the additional responsibility of carrying the idea through, of not letting it die because of inefficient bureaucracies, and avoiding the lost of an opportunity.

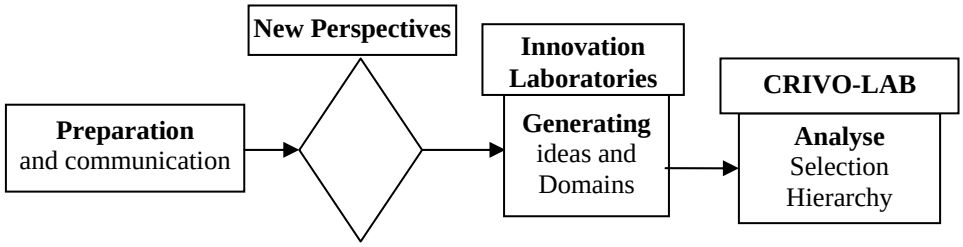
A “suggestions awards” scheme awards employees for creative ideas which have the potential of improving processes, products, quality, communication, safety, culture etc. The “suggestion award” basically gives the employee recognition; monetary awards are not used. According to Mr. Oliveira recognition tactics are what has most impact on collaborators. If the idea is implemented that in itself is already a motive for pride in the employee, in line with theories that support the concept that motivation for creativity is intrinsic. Other recognition techniques include the use of the EFACEC’s newsletter, posters, panels and pictures exhibited in canteens, halls, meeting rooms etc. During the company’s banquets the Executive Committee presents the awards to the deserving employees. This program makes the employees feel satisfied and promotes a creativity culture which enhances “team learning” and the “learning organization”.

4.5. The Workshop Strategy

The other way in which the Innovation Cabinet promotes creativity is through the application of **specific projects** developed and directed purposely at a division. A series of workshops are organized and administered to a wide mix of employees from all departments (manufacturing, R&D, marketing etc.), different hierarchical levels (managers to blue collar workers) and seniority (trainees to 30 years in-house) in the division. This practice emphasizes the importance of diversity in the process of creativity.

On average the Innovation Cabinet administers 10 projects per year, one workshop per day. The average workshop consists of 8 persons who are rotated in order to include as many employees as possible if not all in the workshop. To keep some continuity and overall understanding of the whole process at least 3 employees participate in all workshops, they then have the responsibility of informing the rest of the colleagues. In these projects the same methodology used in the EFAinova project is applied; the next section illustrates and describes this methodology.

4.6. Workshop Organization



Graph 1. From EFACEC Newsletter: ef@news

First Phase: "Preparation and Communication"

This phase prepares the division for the workshops that are going to be administered. The Innovation Cabinet in collaboration with the managers select and inform the participants and make a schedule for the workshops.

Second Phase: "New perspectives"

In this phase the collaborators are going to develop and analyse new perspectives as seen from 4 different lenses. These lenses are going to permit the group to see better and thus identify new opportunities.

1. ***Orthodoxies***

Through this lens methods and processes are questioned. After some time certain behaviours and practices are rooted in such a way that they are not questioned because that is just the way it is. The purpose of this lens is to confront such processes and beliefs of the collaborators and force them to ask why.

2. ***Key Competencies***

This lens enables the collaborators to think and discuss the main competencies that give them comparative advantages; identify what they do well and what differentiates them from the competition. This forces the group to define the key competencies of the business unit and thus share the same perspective. It is surprising some times to find out how much collaborators differ on their business notions.

3. ***Necessities of Clients***

Apply and compare the necessities of clients from other sectors to the clients of EFACEC. How do other sector clients' necessities reflect on EFACEC´s clients; lots of times the necessities are similar.

4. ***Discontinuities***

Analyses of market tendencies in the future; search the Internet; identification of new developments, specialized materials, products, processes. It is an analyses of the present and the future; it is a perspective that takes the group ***from*** today ***to*** tomorrow.

Third Phase: "Brainstorming for new Ideas"

This phase usually takes place in an informal environment; the point is to collect as many ideas as possible; it is not permitted to criticize each others ideas. The 5 W's can be applied here (who, what, where, when, and why) to come up with ideas.

Fourth Phase: "Creating New Opportunities"

In this phase the ideas are analysed, selected, and prioritized. The ideas are connected and potential opportunities are identified. A cross analysis is

performed and there is a focus on the important question word "**How**". This fourth phase kind of gets everybody on track to work towards one direction.

Below are some results of three projects that were administered by the Innovation Cabinet.

- **Innovation in the Robotics Division**
  Theme: Robotics, Preparing the Future
  15 workshops, involved all collaborators
  162 ideas generated
  New strategic orientation

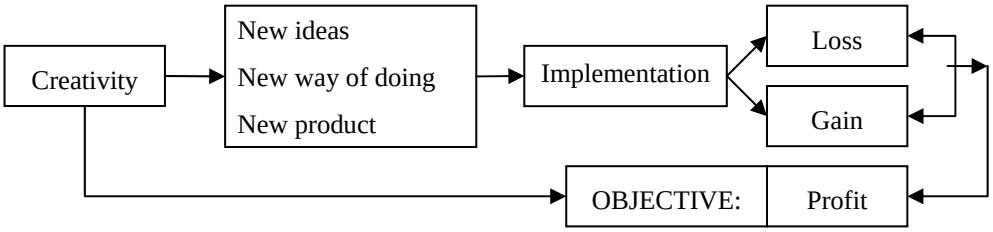
- **Innovation in the High Volt Division**
  Theme: Grabbing the Future
  11 workshops, involved all collaborators
  110 ideas generated

- **Innovation in Energy Distribution Division**
  28 workshops, involved 142 collaborators
  335 ideas generated
  190 new perspectives
  22 opportunities identified

5. Discussion

The main components of creativity according to J. Howells[5] are: **intellectual abilities** (articulation of ideas), **knowledge** (understanding of the field), **style of thinking** (novel way), and **personality** (confidence in own capabilities), **environment** (support & reward for creative ideas).

After analysing different theoretical background and the practical case of EFACEC, I have developed the following perception of creativity in the company.



Graph 2. Definition of creativity in our opinion.

[5] Howells, J. (2005). The Management of Innovation & Technology. Sage. Schilling, M. (2005) Strategic Management of Technological Innovation. McGraw-Hill. Tidd, J., J. Bessant & K. Pavitt (2005, 3rd Edition) Managing Innovation. J. Wiley.

Creativity is a new way of doing things which results in the developpment of new ideas, products and technologies. The implementation of these ideas leads both to financial losses and gains, since not all new ideas are feasible. However, the main objective of creativity in the organization is profit. I do not distinguish the sources of creativity and I consider that human resources are the most important element in this process. Managing human resources successfully with a focus on creativity processes are the biggest challenges that managers presently face, since it has tight interconnection with development of competitive advantages of the firm.

In my view EFACEC managed to fulfil numerous points of what I consider is vital for creativity management. For example it manages to bring together individuals, research efforts of universities, becoming in this way a primary engine of innovation. They succeed in gathering resources so that individuals and the management system can marshal those resources towards a collective purpose.

Organizational creativity is a function of creativity of individuals within the organization. Through the Innovation Cabinet EFACEC controls the social processes and contextual factors which shape how those individuals interact and behave. EFACEC realized the importance of managing efficiently the network of relations in order to promote creativity in the organization.

6. Conclusion

I started this project with the question ”Is EFACEC a creative company?” After gathering information from what the theory says and what I discovered from EFACEC I can answer: YES. The Innovation Cabinet has successfully integrated inside the structures of the group creativity and innovation concepts. For them to be innovative means to be able to overpass the clients’ expectations and to change in somehow the way business is usually done. By redefining these rules they try to obtain new and unique competitive advantages which are difficult to imitate by the competition.

In a world where innovation has become the key of business success every company has to be as creative as possible. As I have seen throughout the paper, creativity deals with the generating of new ideas, while innovation concentrates more into putting these ideas into practice. So the difficult task is to continue to obtain new ideas from the people who work for and with the enterprise. This is done by creating the proper environment in the organization.

The Innovation Cabinet creates this environment in EFACEC. It implements practices and behaviors that support a culture of innovation. It is market oriented when it includes clients in its own workshops, and vice

versa. It promotes an innovation friendly coalition within its workforce through the "Ideas Program" and by including as many collaborators as possible in the "Workshop Projects".

Furthermore the organizational structures of the workshops themselves provide an open spirited atmosphere that propels creativity

EFACEC realized in time that a creative organization needs to be creative in all aspects of business and in order to do that it needs all of its collaborators (workforce, clients, other firms, suppliers, universities, non-profit organizations, the state etc.). Its capability to manage this complex network determines its creativity capacity. It acted by establishing the Innovation Cabinet and giving it autonomy and powers to manage the group's network. Furthermore it motivates people to communicate, creates possibilities and a friendly space to interact. The contribution of all collaborators, not only of top management will be very important and will have a great impact on the future success of the group. In conclusion I can state that through the efficient management of the **workshops** and the "**Idea Program**" the Innovation Cabinet has the power to enhance creativity in EFACEC and therefore a direct impact on the future of EFACEC.

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