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ECONOPHYSICS Section

TWO INTERDEPENDENT BINARY OPINION NETWORKS-ANALOGY WITH CORRELATED ELECTRONS DESCRIBED BY THE HUBBARD MODEL

Karl E. Kürten[*] and F. V. Kusmartsev[**]

Abstract. *We consider an assembly on quantum dots distributed on a lattice often used to simulate strongly correlated electrons with spin up or spin down orientations which sit on the nodes the lattices. Specifically we consider the case when the nodes of the network are occupied or not. We fixed the connection between the nodes by nearest neighbour bonds and for an illustration considered a case when each node is connected to its four nearest neighbor nodes criterion of the final spin up, spin down, empty sites. It is mostly related to the initial stands of the votes before the election started and on the type of the interaction between the agents. However it is important to note that there is a strong diversity of opinions in such a complex networks although in many cases the result of the election is well pre-defined by the initial stand of the votes.*

Keywords: *binary opinion networks, Hubbard networks, Hubbard Hamiltonian, elections.*

1. Introduction

We show that two such competing networks may be considered as artificial physical system consisting of quantum dots (QD). In such a network QDs are nodes and each link indicates that there is an interaction between the connected nodes. Each QD of such a network has a single electron energy level which may accumulate maximum only two electrons with spin up and spin down. The spin up state of the electron will corresponds to the party A while spin down state will correspond to the party B. Due to the Coulomb interaction between these two electrons in QD the single electron energy level is split. This is splitting is the on

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site Coulomb energy U, see the Figure 1. Then, the lowest energy level will correspond to the spin up state, while the upper energy level will correspond to spin down state. If there are no electrons in the QD the site remains empty. If there is one electron in the QD it can have both spin orientations and vote both for the party A and the party B. If there are two electrons, then they can vote for the party A and Party B. In this case the winning party corresponds to the electron with the spin up or down orientation, which occupies the lowest energy level, see the Figure 1.

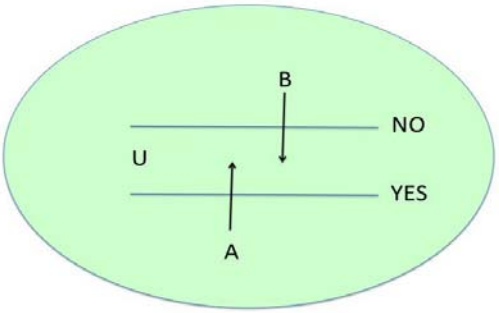


Figure 1. We may put in a correspondence to each agent of the two coupled binary network a quantum dot (QD) which is in Coulomb Blockade regime and may accumulate maximum only two electrons with spin up and spin down. The spin up state of the electron will corresponds to the party A while spin down will correspond to the party B. Due to the Coulomb Blockade the single electron energy level is split, then the lowest level will correspond to the spin up state vote, while the upper level will correspond to the spin down state. If there are no electrons in the QD the agent does not take part in the election. If there is one electron he can have both spin orientation and vote both for the party A and the party B. If there are two electrons, then they can vote for the party A and Party B. The electron with that spin is winning which occupies the lowest energy level.

Note that the ground and excited states of such QDs network as well as its time evolution may be well described by some version of the Hubbard model.

There the single electron energy level splitting in QD, see the Fig. 1, will correspond to the on site Hubbard repulsion U. Next the description of this system will be simplified when we will consider the case $U \to \infty$. There the upper energy level does not play any role and the agent or the QD can have only three choices: 1) no electrons 2) there is one electron with spin up and 3) there is an electron with spin down. Each node of the considered network may be in three different states. On the other hand, the electrons with spin up orientations form the network A and the electrons with spin down orientations form the network B, see, Fig. 2. Thus, the three

states Hubbard network has been decomposed into two strongly coupled binary networks *A* and *B*. If we combine together these two networks by coupling of each corresponding nodes in the network *A* and *B* we reproduce the network which is described by the Hubbard model.

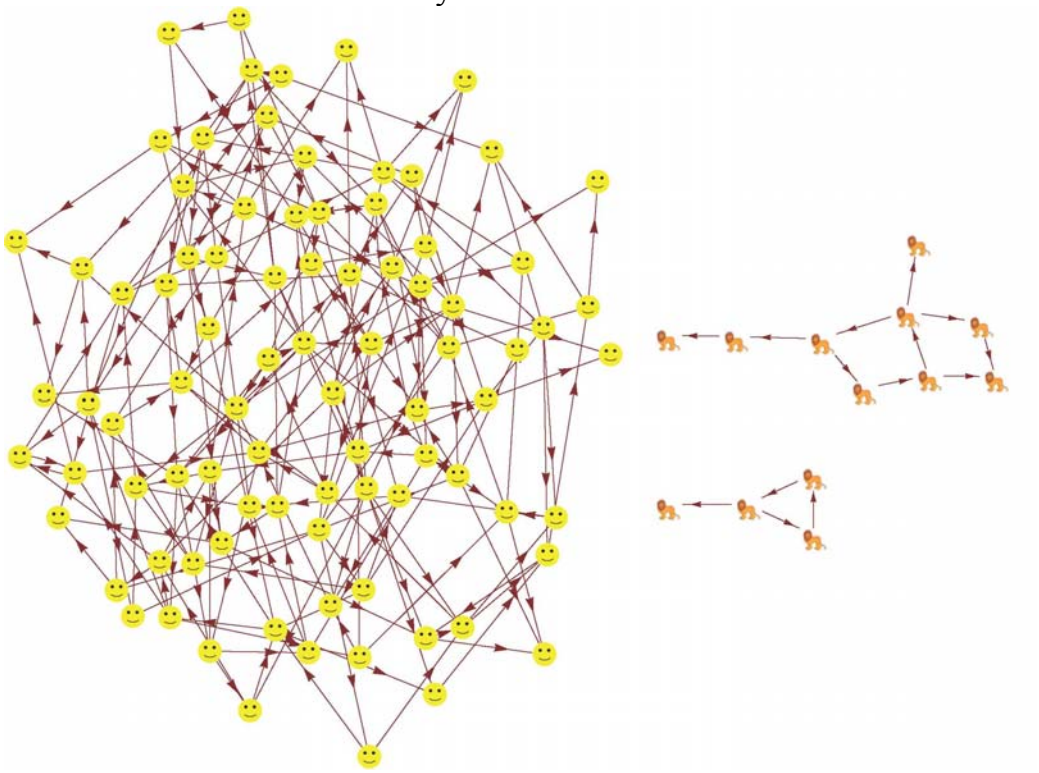


Figure 2. The decomposition of the two strongly coupled (Hubbard) interdependent networks, represented by upper disk, into two separate networks *A* and *B*, represented here by two lower disks. Note that here each node, *i*, in the network *A* is strongly and reciprocally coupled with its counterpart, the same node, *i*, in the network *B*. The sum of these networks, *A* and *B*, gives the example of network coupled with the Hubbard on-site interaction. In other words, such Hubbard network has three states (spin up, spin down and empty states). It is decomposed into two networks each having two states (spin up and empty states or spin down and empty states).

2. Formalism

The network may be described by the renowned Hubbard Hamiltonian:

$$H = -t\sum_{<ij>\sigma} c_{i\sigma}^{+} c_{j\sigma} + U\sum_{i} n_i \uparrow n_i \downarrow + V\sum_{i,j} (n_i \uparrow n_j \uparrow + n_i \downarrow n_j) \qquad (1)$$

The model parameters involve the electron hopping integral t and the on-site repulsive Coulomb potential U and intersite (usually attraction) potential V (usually $U >> V$). The operator $c^{+}_{i\sigma}(c_{i\sigma})$ creates (destroys) an electron with spin projection $\sigma(\sigma = \uparrow \text{ or} \downarrow)$ at a networks site i, and $n_{i\sigma}$ is the occupation number operator $a^{+}_{i\sigma}a_{i\sigma}$. The summations in Eq. (1) extend over the sites i of the whole network A or B. The summation $(\sum_{i,j})$ is taken over all sites i and j which are connected on a network A (B). Note $i \neq j$.

Below we consider the classical limit of the model where the hopping integral t usually existing between all distinct pairs of nearest-neighbour sites vanishes. Then all operators in the Hamiltonian, $n_{i\sigma}$, commute and we may consider the classical limit of the model. The model can describe an array of single or two electron quantum dots, see the Figure 1, where each dot is described as a site in this model.

The lowest energy occupied level with the spin up (spin down) orientation corresponds to the vote "YES" for the network A (B).

We are interested in the dynamics of the models and consider the limit of the Hubbard model, eq.(1) when the value $U/V \rightarrow \infty$.

As the result the model is reduced to the three state modes where the occupation number $n_i \uparrow$ is a classical variable which takes the integer values $n_i \uparrow \in \{0,1\}$ and $n_i \downarrow \in \{0,1\}$. The double occupied state is prohibited. Under this restriction the Hamiltonian takes the following simple form:

$$H = -V\sum_{i,j}(n_i \uparrow n_j \uparrow + n_i \downarrow n_j \downarrow). \qquad (2)$$

In this limit $U/V \rightarrow \infty$ the evolution dynamics of the model takes a more simple form. Below we introduce the classical discrete variables $x_i^{\uparrow} = n_i \uparrow$ and $x_i^{\downarrow} = n_i \downarrow$.

The dynamical evolution of the network may be represented in the form of a cellular automata rule derived on the basis of the calculation of the effective field acting on the agent i. There are in total 81 input configurations based on the actual state of the node itself in terms of self interaction and the three interactions coming from the 3 neighbouring connecting nodes, that is there are $3^4 = 81$ input configurations. The rules may follow from the energy gain or more precisely the energy density gain arguments: 1) during the time evolution the system conserves the

energy; 2) during the evolution the system may gain the energy density. The latter happens when the system loose an electron. Then if the total energy has not changed but the number of the electrons decreases the energy per electron decreases too, that is the energy density gains.

Table 1: Cellular Automata Rules for Hubbard Model.

initial	input#1	input#2	input#3	output state
0	↑	0	0	0
↓	↑	0	0	0
↑	↑	0	0	↑
0	↓	0	0	0
↓	↓	0	0	↓
↑	↓	0	0	0
0	↑	↑	0	0
↓	↑	↑	0	0
↑	↑	↑	0	↑
0	↓	↓	0	0
↓	↓	↓	0	↓
↑	↓	↓	0	0
0	↑	↑	↑	0
↓	↑	↑	↑	0
↑	↑	↑	↑	↑
0	↓	↓	↓	0
↓	↓	↓	↓	↓
↑	↓	↓	↓	0
0	↑	↓	↑	0
↓	↑	↓	↑	↓
↑	↑	↓	↑	↑
0	↓	↑	↓	0
↓	↓	↑	↓	↓
↑	↓	↑	↓	↑
0	0	0	0	0
↓	0	0	0	0
↑	0	0	0	0
0	↓	↑	0	0
↓	↓	↑	0	↓
↑	↓	↑	0	↑

Then, the rules of the group 1 describe the system where all electrons are localised into different ferromagnetic clusters and the clusters consisting of holes. More precisely, the clusters consisting of holes are stable objects and they appear to decrease the energy creating the buffer layers between the ferromagnetic clusters, oppositely oriented.

There the empty sites or nodes remain empty, since the total energy of the system will not be changed.

The rule of the group 2 may describe the intention of a single separate electron that is having an opposite spin than the neighbouring cluster to vanish from the network. Since there is no interaction between spin up and down electrons in our model the existence of such separate electrons is equivalent to the existence of holes.

The energy argument is simply suggesting that this electron will be vanishing from the system. In this case, the energy per electron or the energy density decreases.

Finally the rules from the group 3 describe directly an effect of the ferro- magnetic interaction. Because of this interaction if the electron will join the clusters, the total energy decreases.

These 81 rules split into three classes. The rules belonging to class $N\,1$ say that an empty node always remains empty. In other words, in this network, if the agent has no opinion for whom to vote in the initial stage of the election, then he will not contribute into the election at all. He will always stay at the "zero" – rest state. This means also that if at some time step the agent will fall into the "zero" state he will stay there forever. Thus, during the evolution of this network the number of agents in the zero state increases. The evolution of this network based on these cellular automata rules is reminiscent of variations of the "game of life", where no birth takes place and the population does not die out. In this game each node of the network may be in three states: dead (empty), alive in the state up and alive in the state down. Then the rules of the game are the following:

1) The dead cell always stay dead. This group of rules is presented in the Fig. 3.

2) The cell surrounded by enemies and dead cells becomes dead. These rules are illustrated in the Fig. 4.

and 3) The cell which has at least one neighbour of the same party stays alive, see Fig. 8.

The cellular automata rule is given in the table below. Based on these rules we may anticipate the final state of the parties A and B arising as a result of the evolution of this Hubbard network. In the final state each party must be presented in a form of connected network where each agent is connected with at least one other agent of the same party. For an illustration we present an example of such clusters associated with red and light-blue connected nodes on the Fig. 6.

Thus each party there is presented in the form of the connected network: the party *A* by red nodes while the party *B* by light-blue nodes. In general, for each party there is a whole set of such connected networks of various size. The described creation of the singly connected clusters is analogous to the formation evolution of electronic molecules in a network of weakly bound quantum dots, where electron-phonon interaction is taken into account and plays a significant role (see, for example the references [1, 2, 3, 4, 5]). These clusters are formed due to a short range attraction between electrons due to phonons and on site (Hubbard) and long-range Coulomb repulsion between electrons. An array of weakly bound quantum dots, where there is a rare virtual hopping of electrons between the dots (the vanishing hopping integral as for small polarons) is an ideal system for the formation of such strings and electronic molecules [3, 4]. Indeed the formation of such molecules can be naturally described with the aid of the proposed cellular automata rules.

The rules may follow from the energy gain or more precisely the energy density gain arguments: 1) during the evolution the system conserves the energy; 2) during the evolution the system may gain the energy density. The latter happens when the system loose an electron. Then if the total energy has not changed but the number of the electrons decreases the energy per electron decreases too, that is the energy density gains.

Then, the rules of the group 1 describe the system where all electrons are localised into different ferromagnetic clusters and the clusters consisting of holes. More precisely, the clusters consisting of holes are stable objects and they appear to decrease the energy creating the buffer layers between the ferromagnetic clusters, oppositely oriented. There the empty sites or nodes remain empty, since the total energy of the system will not be changed.

The rule of the group 2 may describe the intention of a single separate electron that is having an opposite spin than the neighbouring cluster to vanish from the network. Since there are no interaction between spin up and down electrons in our model the existing such separate electrons is equivalent to the existence of holes. The energy argument is simply suggesting that this electron will be vanishing from the system. In this case, the energy per electron decreases.

Finally the rules from the group 3 describe directly an effect of the ferro- magnetic interaction. Because of this interaction if the electron will join the clusters the total energy decreases.

The whole set of the electronic polaron clusters randomly distributed over the lattice create some kind of electronic glass. The presented cellular automata rules describe effectively how these polarons form clusters and the variety of the possible states which may arise here. The "magnetizations" describe the electron density for spin up (down) electrons associated with many different clusters described in the first approximation, effectively, by the Hubbard model. It is the ratio of the number of spin up and down electrons to the number of nodes, N, in the network. They are defined as

$$m^{\uparrow}(t) = \frac{1}{2}\sum_{j=1}^{N} x_j^{\uparrow}(t) \tag{3}$$

$$m^{\downarrow}(t) = \frac{1}{2}\sum_{j=1}^{N} x_j^{\downarrow}(t). \tag{4}$$

Besides the density of the votes $m^{A}(t)$ and $m^{B}(t)$ there are other characteris- tics of the networks A and B such as their clustering coefficients, degree and between-ness distributions as well as the eccentricity and diameter of the net- works.

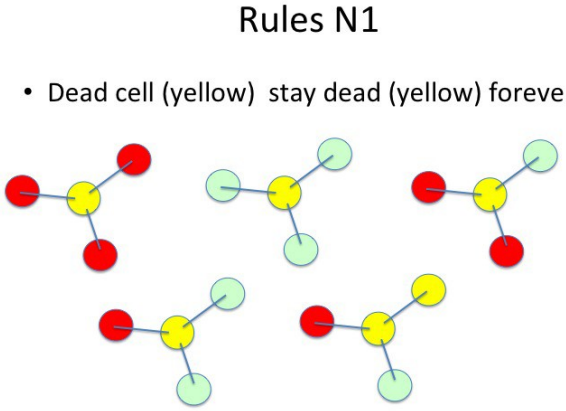


Figure 3. (Color online) Examples for possible configurations of the N1 group consisting of 27 input configurations. The empty cell stays empty if it is sur- rounded by up, down or empty cells.

3. Computer experiments

Provided that each agent i in network A influences its counterpart agent i in network B no rigorous analytical predictions are possible because the neighbours are not chosen at random and hence correlated.

Preliminary numerical simulations based on the choice of random initial conditions reveal that essentially any value of the magnetisation is possible. However, as depicted in Fig. 2, magnetizations close to zero and close to one, which corresponds to high polarizations, are obviously preferred. Note that magnetization zero and one are the only fixed points of the model, where the interdepent neighbours are chosen at random. Hence, we have multistability, a familiar phenomenon in the theory of interconnected dynamical systems. We also observe that the party with higher fraction of initial votes always wins, where the winner takes always more than 50% of the votes.

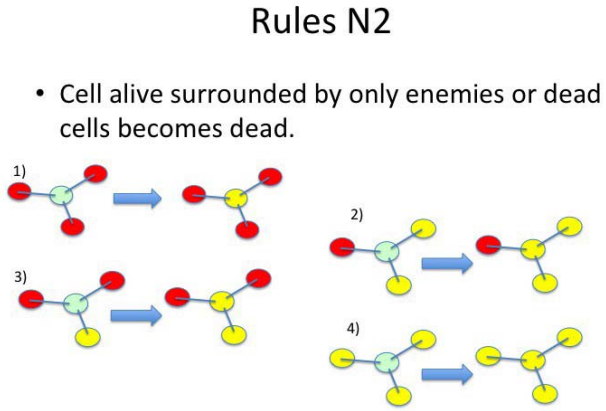


Figure 4. (Color online) Examples for possible configurations of the N2 group consisting of 16 input configurations: if an up electron is surrounded by only down or only empty cells, it vanishes, respectively for a down electron.

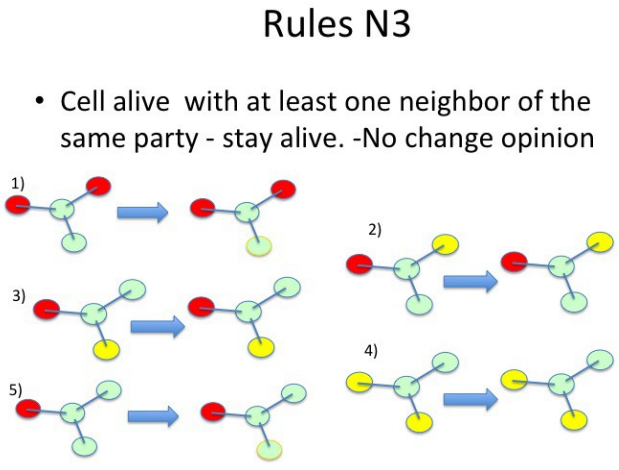


Figure 5. (Color online) Examples for possible configurations of the N3 group consisting of 38 input configurations: if an up or down electron has neighbouring relative electrons, it stays alive.

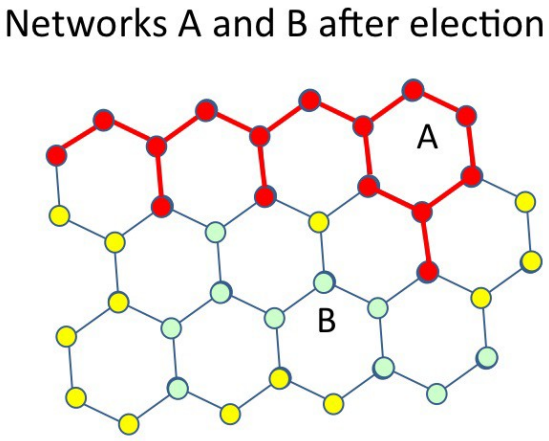


Figure 6. (Color online) An arbitrary example of a shape of cluster, which may arise as a result of the evolution of the network. For a simplicity the clusters is presented on a two-dimensional lattice. The red nodes correspond to the party A while the green nodes correspond to the party B.

4. The role of the initial fraction of up and down spins

Since the model has no control parameter, the asymptotic behaviour of the system depends uniquely on the initial conditions. In order to classify the outcome let us introduce the ratio of the two initial conditions

$$r = \frac{m_B(0)}{m_A(0)} \tag{5}$$

such that we have $m_B(0) = r\, m_A(0)$ with $0 \le r \le 1$, where $m_A(0)$ is specified by choosing the microscopic quantities $x_i^A(t=0)(i=1,...,N)$ at random that implies $m_B(0) \le m_A(0)$.

The extreme case $r = 0$ implies $m_B(0) = (0)$ such that the two networks decouple and we have the time evolution of the basic single network according to Eq.10 and recover the fully polarized state (1, 0).

Be p the fraction of spin up and $(1–p)$ the fraction of spin down electrons. The probability that we find an isolated up or down particle is then

$$P = p(1-p)^4 + (1-p)p^4. \tag{6}$$

As to be expected, for small values of r we still find near-polorized states as shown in Fig. 4 for $r = 0.1$ and even $r = 0.25$, where the fraction

of fully polarized microscopic states is still 0.8 and 0.5, respectively. This fraction of fully polarized microscopic states decreases linearly with increasing values of the ratio r and eventually vanishes at $r = 0.5$.

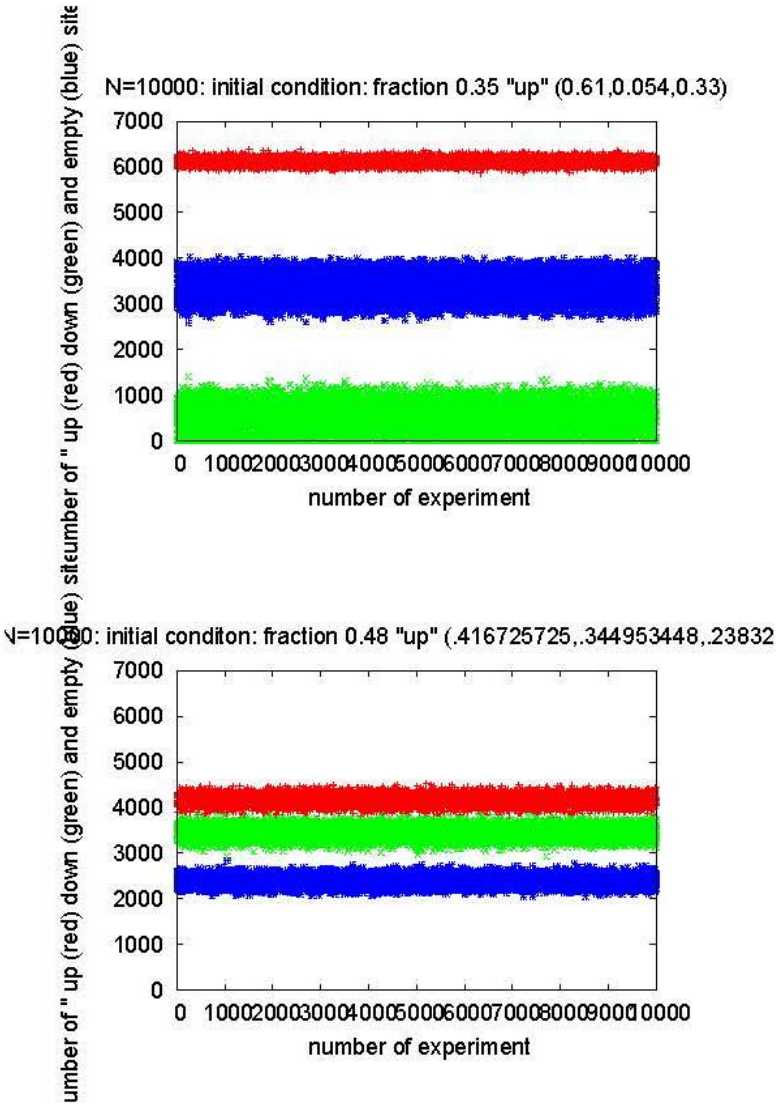


Figure 7. (Color online).

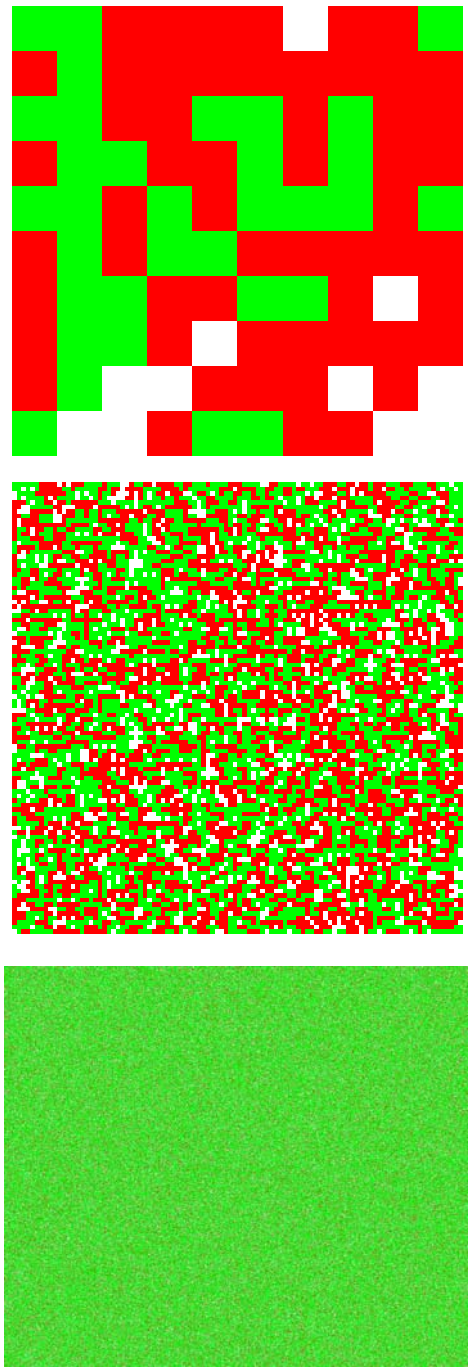


Figure 8. (Color online)

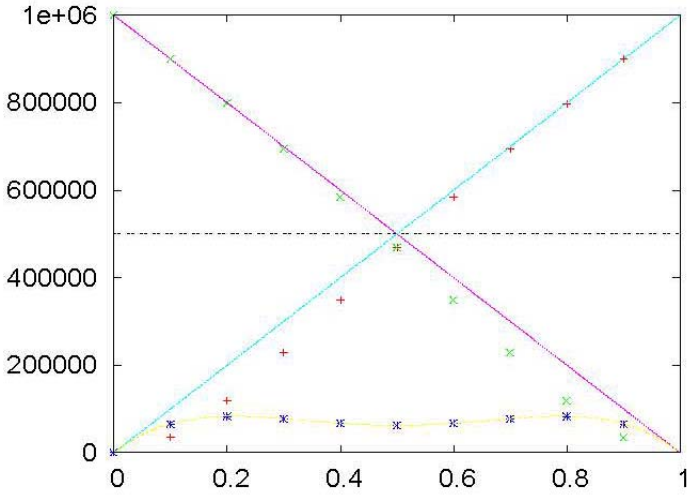


Figure 9. Distribution of the asymptotic magnetizations for ratios r = 0.25, 0.50, 0.75, 0.90, 0.95 and $r = 1$.

For the ratio $r = 0.7$ the gap between the acceptance of product A and product B diminishes, while we do not find any polarization, although we still have a clear decision in favour of product A.

For $r = 0.98$ the acceptance rates for both products vary around 0.5 often without any clear decision for the YES or NO state.

5. Summary

We found that the evolution of such two competing party system or two binary networks is well described by a version of the extended Hubbard model usually used to simulate strongly correlated electrons. In terms of the Hubbard model the giving votes for the party A or the party B corresponds to the spin up or spin down orientations of the electrons which may sit on the nodes of the networks. Specifically we have considered the case when the nodes of the network are occupied or not. This case has been described in the framework of the Hubbard model when the Hubbard interaction $U > 0$ goes to infinity, where no double occupancy on the nodes of the network does exist. We have considered the time evolution of this network. We fix the connection between nodes and in general it can be K connections. Specifically we consider the case when each node is connected to three other nodes. The electrons having

the same spin orientation and located on the connected nodes were interacting with the constant $V < 0$ – the attractive extended Hubbard interaction. Due to this interaction there arises an effective field acting on each electron of the network. Depending on the field the spin of this electron can be flipped. At each time step of the time evolution we date up all nodes of the network in parallel according to the dynamical rules. As a result we have obtained the momentarily pattern of spin up electrons distributed through the network A – the state vector of the network A, and the same for spin down electrons – the state vector of the network B. At the next time step $t+1$ we apply the same dynamical rules and obtain another pattern at the time $t+1$. The procedure has been repeated until we will reached the fixed point.

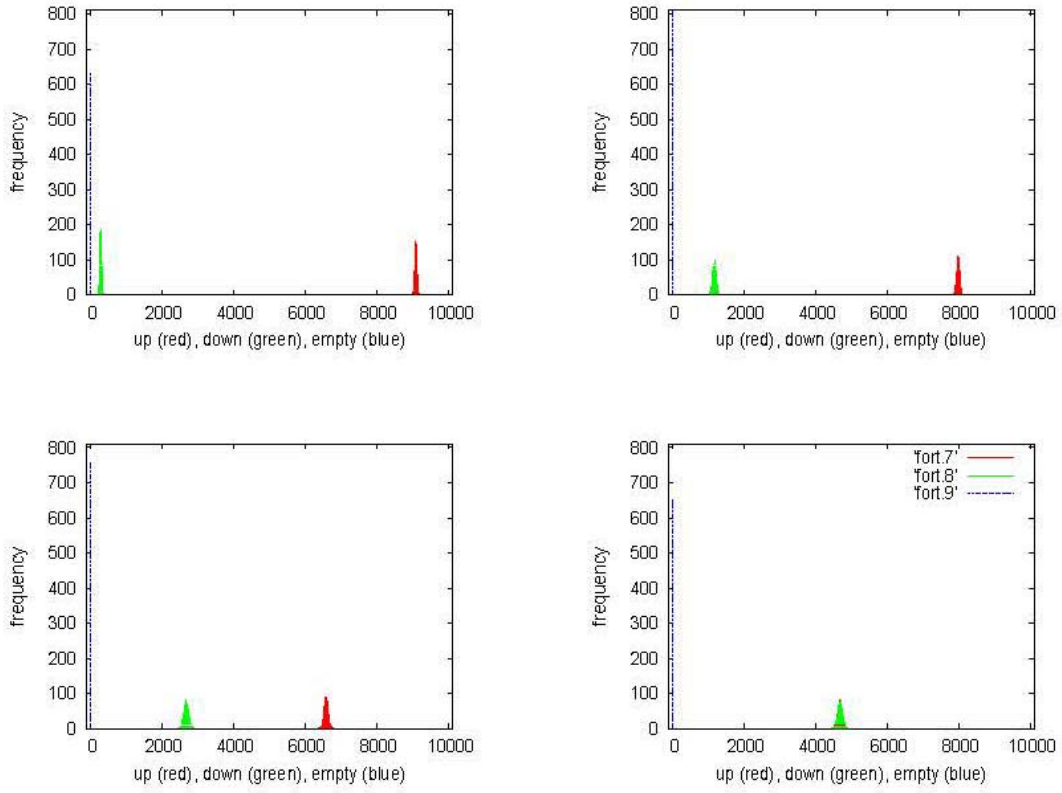


Figure 10. Distribution of the asymptotic magnetizations for ratios r = 0:25; 0:50; 0:75; 0:90; 0:95 and r = 1.

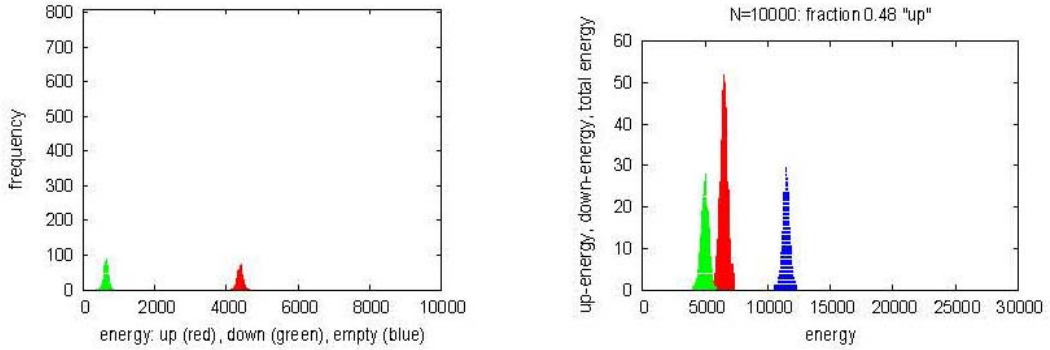


Figure 11. Energy of different configurations, when the parameter r = 0:75 for ratios r = 0:25; 0:50; 0:75; 0:90; 0:95 and r = 1.

As a result of our numerical simulations we found that the final pattern of the spin up and spin down configurations depend strongly on initial conditions. Especially it is important the initial ratio of the total number of spin up and spin down electrons, $N_{\uparrow}(t) = \sum_{j=1}^{N} x_j^A(t)$ and $N_{\downarrow}(t) = \sum_{j=1}^{N} x_j^B(t)$ respectively.

The party A beats the party B if the initial number $N_{\uparrow}(0) > N_{\downarrow}(0)$. There are exponentially many different configurations arising due to different initial conditions. Some of these configurations will appear more often, i.e. with larger probability and some of these configurations are less probable. We estimated this probability and presented it in the form of histogram describing well the distribution of $N_{\uparrow}$ and $N_{\downarrow}$ as well as magnetisation defined as $m_A = N_{\uparrow} / N$ and $m_B = N_{\downarrow} / N$ and energy associated with the different configurations. Usually the energy of the excited states corresponds to complex configurations associated with larger values of the entropy.

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FROM RIEMANN HYPOTHESIS APPROACH VIA THE THEORY OF CATEGORY TO MODERN MONETARY THEORY

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Abstract. *The Riemann and Goldbach hypotheses are explicit respectively since 1859 and 1742. The proof of the validity of these hypotheses is today unknown because the mathematicians face a major difficulty due to entanglement, – insurmountable in the frame of usual arithmetic – between addition and multiplication included inside the zeta function expressions. A progression, step by step upon the different pillars of the theory of category highlights nevertheless a fundamental decoupling between both concepts within 2 distinct monoids* $(N+)$ *and* $(N\times)$ *upon the field of natural numbers. Then we can show the consequences of putting them in coincidence. This coincidence brings to the emergence a renormalization group which, applied to the Riemann zeta function, provides, via the theorems of Voronin and Bagchi, mathematical proofs of the validity of both hypothesis.*

For fundamental reasons the authors assert the existence of a relationships between zéta function and the dynamics of complex systems. The economic system being among others, an example of complex systems, the authors show that the Adam Smith assumption concerning the invisible hand of the market is only relevant if the concept of equilibrium and/or steady state are relevant, that is to say, if the set of the zeros of zéta function is able to represent the spectrum of the economy. Nevertheless, in this case the economy is static, it behaves like a close-system, and evolution is no other than the result of strictly random processes.

The Riemann hypothesis is solely associated to the zeros of the zeta function; therefore, this hypothesis excludes any consideration about the environment of the set of zeros. It tells nothing concerning the functional relationships that characterize the fundamental symmetries of zeta functions. But, these functions staying partly determined by the renormalization group, this group becomes the source of freedom that is hidden when focusing on the field of the zeros. Outside of the zeros field, the splitting (the decomposition into a product of primes, or in terms of physics, in the characteristic time of the each specific action) leads, to a symmetry breaking and to the emergence of entropic factors. These factors invalidate the market efficiency hypotheses and fundamentally accredit the role of decisions and axiological choices.

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The zeta splitting explains the requirement for currency in economic exchanges. We show why the monetarist hypothesis can be associated with the characteristics of the zeta function and why the symmetry breaking induces the importance of the role of a monetary policy in economics.

Keywords: *Riemann Hypothesis, Categories Theory, Fractal and Hyperbolic Geometry, Path Integrals, Irreversibility, Management, Modern Monetary Theory.*

1. Introduction

For any beotians the mathematics differs from physics, in that the foundations of this science concerns natural objects, and not abstract entities. But a deep analysis of this topic shows that this point of view is not so simple. For instance, the mathematical physics is the science of axioms and logical consistencies from which 'scientific objects', for instance 'atoms', emerge. These 'beings' are obviously 'technical beings' but they contribute to our representation of the real world because they raise our capability of experimentation or of falsification. This capability results mainly from the checking of invariances in algebraic relations, whose archetype is the symmetry relations (Boson *versus* Fermion; Matter *versus* Antimatter, etc). In category theory, the equivalents of these relations are named homomorphisms [21, 22]. The ambiguity of the concept of 'scientific objects' can then be expressed through the relations between operators (fonctors). It is a specific mathematical object. As Dana Mackenzie notes in the book about the morphisms of algebra [30], the implementation of a couple of operations within a field, – if the second operation is managed through a neutral element –, leads to what we name a group of transformations. For instance, the operations $(+,-)$ *or* $(\times,\div)$ - define a Group. It differs upstream from morphisms on a field characterized by 4 algebraic operations with two neutral elements $(+,-,\times,\div)$. They also differ from unitary rings which compute 3 operations with only a sole neutral element, the unit $(+,\times,\div)$. They are also distinguished downstream from morphisms upon the associatif unitary magma. Magma is associated with the concept of half-group. If, this last is regular, the magma is called monoid. The concept of monoid is defined by a single operation -on a certain field, N hereafter. Monoids can be associated as contravariant operations. For instance, we can define a product $(N\times)$ and its co product $(N+)$ respectively inductive and projective covariant structures. The aim of this note is to address the emergence of

one-parameter groups resulting from the coincidence between $(N\times)$ and $(N+)$. According to an historically vision, we must note that in his treaty titled monadology [29,32], Leibniz concluded – against Newton whose aim was to reach the 'scientific object' through its universality by taking the time away-that the links between a couple of monads, leads the emergence of a fundamental pattern (represented by a pond in his masterpiece) which is named renormalization group, in our current mathematical language (Monadologie § 67). This last is a group having a sole degree of freedom [5,45]. This degree may be reducible to the usual temporality [5]. This 'historical' parameter might justify the increasing of complexity observed through the phylogenetic tree. The purpose of this note is to highlight the internal dynamic meaning of the word 'complexity'[28]. The analysis will be built from a specific categorical approach of the resolution of the Riemann conjecture (1859) [3, 8, 9, 17, 35, 41]. The Goldbach hypothesis (1752), will be left for other publications [37].

2. First puzzle elements

The Riemann hypothesis concerns the properties of the zeros of the series $\zeta_D(s) = \sum_n b_n (n)^{-s}$ respectively Riemann and Dirichlet series if $b_n = 1$ or $b_n \neq 1$. These series depend of a complex variable $s = \alpha + it$, with as usual $i^2 = -1$. These functions are also expressed using primes with, for example $b_n = 1$, $\zeta(s) = \prod_{p \in P_1} 1/(1-p^{-s})$. More precisely $\zeta(s)$ is the only analytic function upon *C* the integer complex set, private of the unit, in coincidence with the series for $\mathrm{Re}(s) > 1$. The Riemann hypothesis also relates the link between the Riemann functions and analytical functions of the form $\sum_n a_n (s)^{-n}$. In the field of analysis this connection operates through the Voronin theorem [44] which asserts that it is possible to approximate any holomorphic function by using an 'universal function', the Riemann function being precisely a member of this class of functions.

By involving the complex variable in a power expression, the analytic functions acquires a remarkable property that is no less than the one-unit increase in the dimension of freedom of any real variable function. This conceptual step radically changes the usual physical standpoint because it overcomes the role of singularities – that must be removed in physics. This feature gives to holomorphic functions the complex parametrization of any

hyperbolic manifold [7, 11, 12, 14-16, 25]. The time parameter, usually used to represent status change and the dynamic state of a 'scientific object', is then split within two parts. This new class of representation increases considerably the possibilities for physical treatment of the dynamics by replacing a sole geodesic, like a serie of 'steady states' depending on time, by a manifold seen as a functional series. Initiate a study on analytic functions is therefore equivalent to add a freedom in the dynamic of any processing. This freedom allows for bypassing eventual catastrophic situations when many steady states are in competition. Another aspect of the complex extension is related to the peculiar duality rising between analytic and Riemann function, this last function inverting the role of the power law with respect to the analytic function with $(n)^{-s}$ while the analytic function is expressed using a polynomial form, in which the complex number s is a variable to a certain power $a_n(s)^{-n}$.

This duality raises a major difficulty when it is carried through an algebraic sum as it is usual in measure theory. The function $\sum_n a_n(s)^{-n}$ is then a function in the form of a series expansion, the traditional meaning being in this case a Taylor series or a Fourier transformation, so that, the zeta Riemann function $\zeta(s) = \sum_n (n)^{-s}$ and its equivalents characterized by b_n, raises difficult mathematical and physical problems [34] requiring new concepts such as the concept of 'virtual-set', concept introduced by André Joyal in the framework of category theory. The physical meaning of this concept is an embedment of a singular set into a continuous matrix, afterward cut into infinitely thin slices [38] and analysed from the state.

Starting from Voronin theorem [44], the Indian mathematician Bagchi [3] managed to demonstrate that Riemann hypothesis, -asserting that the zeros of the function $\zeta(s) = 0$ are located in the complex plan strictly upon the line $\alpha = 1/2$ $(s = 1/2 + it)-$ is true if and only if $\zeta(s)$ is self similar that is to say if it verifies $\zeta(at, s) = a^{\alpha}\zeta(t, s)$ This feature is qualified by the word renormalization [45]. Like on fractal curves a similitude then exists between every part of its diagram and the whole of the function.

The authors are not only concerned by solving the cited hypothesis (Riemann and Goldbach), which establish the conditions of validity of the classes of zeros and their consequences in arithmetic, but also by an another question of practical importance in physics, which is the

following [7,]: *if the conjecture is true, (i) what meaning does it give the Riemann function outside its zeros and then (ii) what meaning can we attribute to the well-known functional relationship* $\xi(s) = \xi(1-s)$ *that impose an ad hoc 'symmetry' on either side of the critical affix ½* ? We have to remind that the parity is expressed through the function $\xi(s) = \frac{1}{2} s(s-1)\pi^{-s/2}\Gamma(s/2)\zeta(s)$ that is to say [9] via some projections involving the combinatorial gamma function. The parity explicitly links the reversibility of a variable looking like a time parameter (associated with complexe part of s (see Voronin theorem)) and the zeros of the zeta function. At this step, we do not know through what kind of artefact the link may be established. The development that follows will help to understand that this constraint is related to an epistemological issue that could be summed up as followed: except within a few number of specific cases (example in quantum mechanics [12]), the natural state of a complex system can not be distributed (and therefore vectorially represented) upon a set of stable states; therefore it cannot be reduced to an 'object of science' [28, 37]. This last was thought to be solely associated with a pure reversible time-space, hypothesis obviously false herein. In almost all cases the vectorial system of representation based upon stable states is incomplete and the human action is necessarily faced with a duality (more generally at a singularity of choices). This last must be transcendental and must choose a reference outside of the system of axioms [29, 32].

This theoretical constraint undermines any will of computation of an 'optimal human action'. Except in very special cases, it is indeed not possible to determine intuitively or rationally, a self-coherent solution of an issue into a complex problematic. So the question of our ability to understand (or to close) a functorial problematic is inextricably linked with mathematical questions, which are still widely misunderstood (except by few mathematicians), and the probability of what could be understood and solved at short term, concerning the hereinabove hypotheses, seems very low. Among the issues that concern us in the first place, there is the econo-logy. Aside, the insurance, and even the arrogance, that the economic scientism may display [10], the econo-physics could become, if we do not take conceptual precautions, a mere sycophant. Obviously that is not the will, of the experts in charge of the science of complex system. The opinion of the authors is that, in front of the econo-physics, the econo-logy should pave the way for a categorical rehabilitation of the 'policy'. This 'sciance' [42], developed through structuralist patterns, – instead of answering to a mere will of 'reification' of our representation of the real –,

should help us to streamline our relationship to the reality seen as a dynamic research because this reality is now partly the result our technical creations. We will try to show how the new approach of Riemann hypothesis applied in the framework of categories theory [21, 22, 37], can help us to understand the differences aspects of the above comments.

3. Riemann hypothesis in the framework of the theory of category: state of the art

3.1. Categorical introduction

The zeta function $\zeta(s)$ occupies a prominent place in mathematics. In addition to its role in arithmetic (Euler, Riemann), in combinatorial algebra, in the theory of functional operators, or in the mathematical formalization of thermodynamics, this function has appeared more recently in category theory [see 36]. Through renormalization methods [16, 39, 41], this function has aquired an admittedly less ancient role but no less promising in quantum mechanics, in quantum field theory, in the theory of fluctuations, as well as – via the non-commutative geometry [5] – in quantum gravity and loop theories [40]. Recently the physics of heterogeneous media highlighted the close connection between this function and the engineering problems in fractal geometry [20, 24]. The aim of the current works is to suggest a new mathematical approach for solving of the Riemann hypothesis in the framework of category theory. Indeed, the rules upon the functors and the related theorems allow the authors to highlight the presence of a close connection between the Riemann function $\zeta(s)$ and a general principle of coherence inside a couple of contravariant algebraic concepts [2, 28, 36]. Among examples of contravariant couples let us note: algebraic structures versus its coalgébrique structures; limits and colimits diagram; variables versus parameters, etc. Beyond these achievements, let us observe that the general principle of coherence of a couple of contravariant concepts underlies a great number of mathematical methods of resolution. Let us note for instance the Lie-Trotter formula that is the corner stone of the study of semi-groups of operators or as well, the theorem of Dold-Kan-Puppe in homological algebra. In physics and engineering let us note the structure of the formal thermodynamics, the Maxwell and Dirac equations, or the link with the efficiency of batteries. Beyond this brief overview, we also know that this principle is also involved in a systematic way in the construction

of self-similar structures, when they are seen as strange attractors, characterized by renormalization groups and by fractal structures [25, 26, 27, 31]. The authors assert that the categoric approach allows approaching the understanding of the famous conjectures still pending and allows solving numerous complex problems that may be written in the frame of a universal class of categorical issues.

Beyond the precautions required for the definition of its field of validity, it is well known that the function $\zeta(s)$ can be considered from two separate formulations given by a couple of series, involving the operator sum Σ with indexes belonging to any integer N, and secondly an infinite product Π, where the subscripts concerned the set of primes. Subject to consider the categorical asymmetry between addition (coproduct) seen as projection and product seen as surjection, any specialist of categories or even expert in formal languages, may have the intuition of the matching of two monoids – the first being additive the second being multiplicative –, as an opportunity for the renormalisation group, to emerge [36,37].

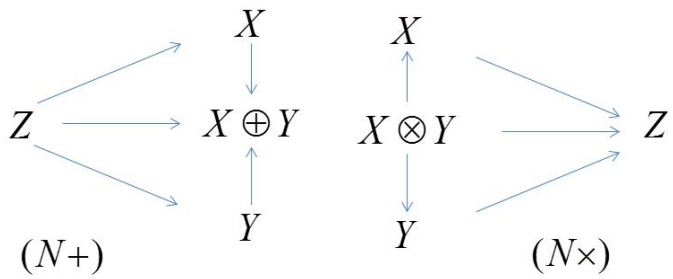


Figure 1. Main categorical algebra distinctions: Product (Partition) *versus* Coproduct (Union). Note the inversion of the arrows to understand the rising of a group through coincidence of the limits. For instance cellular automatons are based on such a structure. Even useful, this diagram is misleading because it supposes a fantasized existence of a final colimit of the cone of the product.

At this stage we cannot neglect a peculiar distinction which has to be considered: if the additive monoid has a clear initial algebra given by $N + 1$ and due to the role of infinity, the multiplicative monoid has not a natural final algebra. This dissymmetry may contribute to render the diagram above, misleading. Obviously, and this point is precisely the main difficulty of the resolution of Riemann hypothesis, this asymmetry must be overcomed to allow to the regular arithmetic consistency. This last is required for reducing the multiplication as to be a sum of additions. Nevertheless, it is obvious that in the case of the zeta function, this putting

into coincidence will be complicated by both (*i*) the involvement of primes (atoms of arithmetic) and (*ii*) by the power laws which contribute still more, to the entanglement between the addition and the multiplication hidden into the Riemann hypothesis. Nevertheless, with reference to the usual use in semi-group theory and in the theory of monoids, we may consider the prime numbers such as letters ordered by the lexicographic order of an alphabet of countable infinite size. Any integer *n* is then seen as a word uniquely written in this alphabet with the additional property that the product of two distinct primes remains commutative (the commutative allows moreover an interesting interpretation in terms of automatons or of dependent graphs as well as associated traces). Then, we have for all $n \in N$ $n = \prod_{\{p_i\}} p_i^{r_i}$. It is then useful to suggest a geometric translation using in addition, a linearization of the function $\zeta(s)$ through the relation (*) $\log n = \sum_{\{i\}_{fini}} r_i \log(p_i)$.

3.2. Heuristic approach for solving the Riemann hypothesis [36]

Given a linear space Υ characterized by a dimension $\aleph_0$ where a subspace of dimension 1 is associated with each prime number. Each two dimension sub-area, is then associated with two independent prime numbers. Since it has a non-empty and finite set of coordinates in *N*, if the semi-ring *N* is used as a scalar law, it becomes obvious that, according to the equation (*), each point in the space Υ: $\{r_i\}$ may be enter into a bijection ***B*** defined punctually, by a unique integer. Then let us introduce into the original linear space, an isotropic homothety ***H*** with an amplitude *s* (*s* belonging to a field, typically $s \in C$ the set of complex numbers), then $H_s : \{r_i\} \to \{-s \times r_i\}$. Using the bijection ***B***, this application corresponds to a functional projection $n \to n^{-s}$, defined upon *N* with a co-set ***C***. Note here the introduction of the negative sign for a reason of convergence that will appear naturally in the analysis. Through the above processing, the set *N* is represented by a discontinuous topological set of points whose coordinates are integers. All other coordinates are zero. Therefore the whole set *N* can be 'measured' at different scales *s* through the Riemann function $\zeta(s)$.

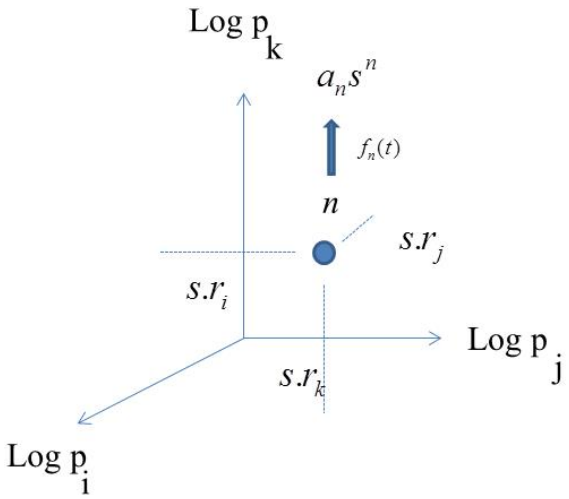


Figure 2. Original 'Zeta-Primes' diagram [36] based upon primes number and used to built analytical function. The total measure of the infinite set of points has zeta function as reference. The parameter *s*, in the relevant compact complex domain, is no more than the stretching factor of the axis, that is to say, the scaling factor of the Riemann Measure (zeta function). Self similarity appears obvious in the framework of this representation.

The measure of Υ is hereafter identified with $\zeta(s)$ seen as a sum of unit through n^{-s} in bijection ***B*** with *N*. In other words $\zeta(s)$ must be understood as the total measure of a discontinuous topological space seen at different scales *s*. Surprisingly, to our knowledge – except communications already issued by the authors of this note [36] –, this interpretation of $\zeta(s)$ as a measure of this type of space does not appear in the mathematical or physical literature.

In the same space Υ we can also consider a second operator defined by two sets of parameters: A global parameter $t \in C$. In practice this field *C* is the same as that which sets the scaling parameter *s* for zeta. A mathematical operator noted *F* establishes a link between an analytical function and each point with integer coordinates $\{r_i\}$. Obviously *t* may be match with *s* if necessary because a collection parameters $\{a_n\}_{n \in N}$ indexed upon *N* is given so that an analytical weight $a_n s^n$ can be given if *n* is defined by (*). Indeed as before, we may consider the total measure of the operator. The measure can define by (**) $f(\{a_n\}, t) = \sum_{n \in N} a_n t^n$ (**). For both classes of operator: (*i*) the amplitude of scaling is *s* and (*ii*) the

operators that assign a weight $a_n s^n$ *to* the corresponding point via the bijection ***B*** with the integer *n*, (that occurs in the filed considered for *s* =1), is given by the point corresponding to the translated obtained by amplitude of scaling $s+it$. In other words, the point corresponding to the integer *n* by the formula (*) considered in the expanded space with an amplitude *s*, is associated the weight $a_n s^n$. Geometrically, we can consider the graph of the operator *F*, then stretch the coordinate space with the factor *s*. If the functional weighting is such that its initial measure given by (**) is bounded, the coefficients evolve in an appropriate field, and the total measure of functional is given by (***) $\xi(s+it)-f(\{a_n\}_{n\in N},s)$.

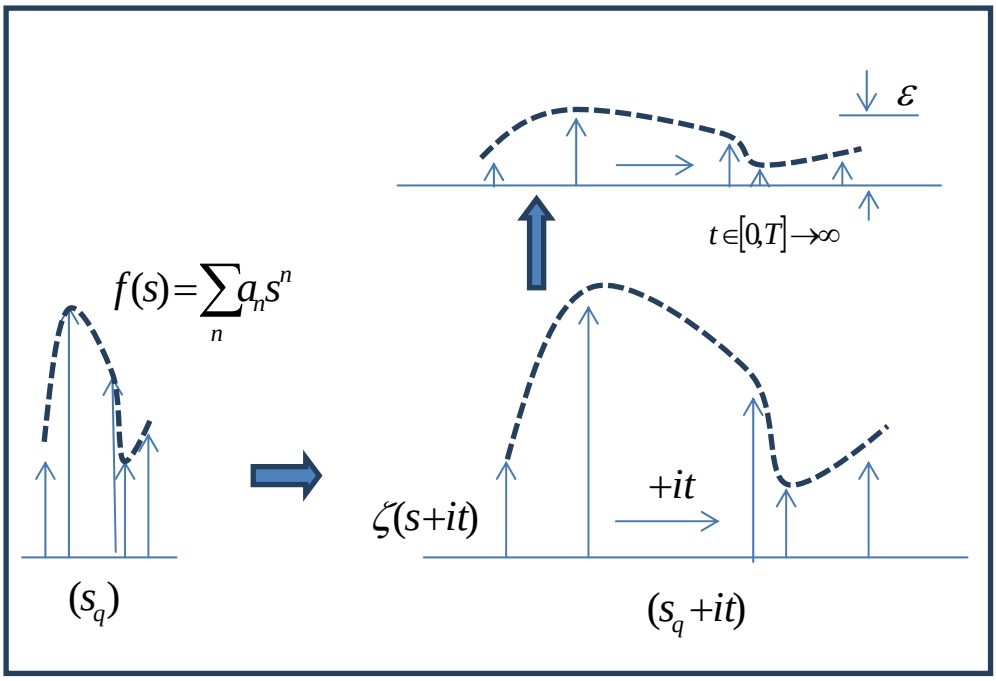


Figure 3. Schematical significance of the universality of the Voronin theorem [44] in terms of stretching of the Zeta-Primes Diagram. The basic line refers to the Riemann measure (zeta function).

Let us suppose that *t* increases to the infinite, the graph of the function *f* tends to 'flatten' upon the coordinate space. This property can be interpreted by stating that the measure of $f(s)$ is infinitely close to the measure of $\zeta(s+it)$ upon a set having a zero measure. This statement is none other than theVoronin' point of view ([44]****):

$$\forall \varepsilon > 0, \liminf_{T\to\infty}(1/T)mes\{t\in[0,T];\max|\zeta(s+it)-f(s)|<\varepsilon\}.$$

This explanation may sound far from mathematical formalism, but it is justified because both mathematical and intuitive approaches, give a deep understanding concerning the Riemann function $\zeta(s)$ through the analysis which was established in 1975 by Voronin [44] and whose precise statement is the following: *For K a compact set in a critical field* $½<s<1$ *with a connex environment and for f(s) continuous function with out zero in K and analytic inside,* (****) *is true,* which means in other words that any analytic function can be infinitely approximated by the zeta function, that is universal in the sense of Voronin. The combination of these couple of approaches is a serious indication that the understanding of the Riemann hypothesis using the discrete topological space Υ and the categorical operators are probably able to restore the essential of the properties of $\zeta(s)$ functions.

The step used to interpret the Voronin theorem is important for at least two reasons: (*i*) it allows to introduce and interpret the Bagchi's theorem [3], which autorize the connection between the scaling properties of zeta function and the Riemann hypothesis. Indeed, shortly after Voronin had established his theorem (1975), Bagchi proves (1982) that the relevance of the Riemann conjecture is strictly equivalent to the asymptotic condition which would concern the measure contained in the Voronin theorem for the limit case $f(s) = \zeta(s)$. On the other hand (*ii*) the geometric representation of discrete space we designed to build the function $\zeta(s)$ as a distribution upon *N* is satisfied by a simple scaling of the discrete space in bijection with *N* in relation to himself. Being acquired elsewhere, that this space is patently self similar, the approach leads naturally to base the validity of the Riemann conjecture by confirming the Bagchi hypothesis.

In addition, as expresses by the summation formula $\sum_{n_1 \times n_2 = n} f(n_1) g(n_2)$ to describe the process in Υ(2D) extent, let us observe that the function $\zeta(s)$ introduced by scaling operator is defined by series which implicitly involves natural convolution products. In contrast, the second functional *f*(*s*) (**) constructed for the need of the case, is structurally combined with an additive monoid $(N+)$. But as suggested by the universality of the function $\zeta(s)$, the conjunction of both algebraic monoids – we shall show what requires a matching between a co initial algebra associated with *N* associated with $(N+)$ and constructing of a specific final algebra associable with $(N\times)$–, should lead the emergence of a group, which can only be a group to a single free parameter upon ***C***. Due to the initial scaling properties, it can be shown that this is a renormalization group, confirming

the self-similarity of $\zeta(s)$. The diagram below provides synthetic approach of the demonstration of the Riemann hypothesis based upon monoids coincidence. Subject to passing to the limit, the two distinct monoidal structures can be combined, involving a categorical compactification. Nevertheless, due to the role of infinity, this path to a limit is not so easier for the multiplicative monoid. We shall see, in the framework of categories theory, which kind of 'projection' is required, to make this transition in a mathematical relevant manner, and how an ad hoc projection causes a natural emergence of self similar features.

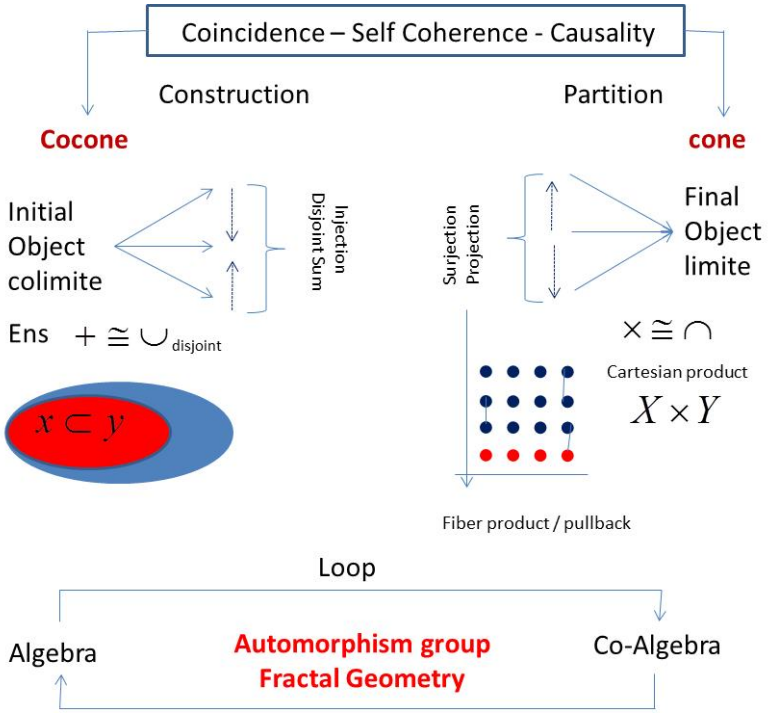


Figure 4. Diagram giving – through the coincidence of algebra with coalgebra and of the count with the measure – the principe of the self coherence of both points of view: construction and partition. The action of forcing the coherence causes the emergence of renormalisation group also characterized by the emergence of time irreversible factor.

4. Yoneda lemma, Kleisli category: physical meaning and applications

In the frame of universal algebra, the connection between the final inductive algebra associated with the product monoïde $(N\times)$ and the initial

projective coalgebra associated with the monoïde $(N+)$ has to lead to the emergence of a group. At this stage, we assume that this group is a group of renormalization characterized by one degree of freedom but we have to prove it. Downstream the arguing, this group must validate the demonstration of Bagchi's theorem upon the Riemann hypothesis [3]. The closure (Figure 4) requires a 'practical con-fusion' hence, in physical terms, the emergence of an entropic factor in the sense of thermodynamic theory. This factor led to the assimilation of the parameter of order of the renormalization (spatial in Υ) with a parameter usualy named the 'time', expressed in the field of complex numbers. Due to ambiguity factor, we can then assert that this parameter contains at least one dynamical irreversible component. Given the universality of the Riemann function and by arguing from the theorem of Voronin, it should be possible to find, in the physic of complex systems, some analytical functions related to fractal properties pointing the irreversibility. In this case they should be approximated by part of Riemann functions or extensions of them. Well before the current analysis, this is exactly the fact that one of the authors highlighted by pointing out in 2008 [26,27], a link between the Riemann series and a self-similar canonical distributions associated with transfer functions in heterogeneous media qualified 'Cole and Cole' transfer functions [23, 24, 25]. These functions confirm the link between self similar characteristics, which is the geometrical background of the fractional derivative operators [24, 25], the basis of the Cole and Cole transfert functions and of the zeta series. Nevertheless, the issues resulting from the physical publications need for being mathematically justified, of at least two additional ingredients which can be extracted from the theory of categories [36, 37]: The first ingredient is the Yoneda lemma. It must justify the rôle of a certain phase angle use in the physical approach of the conjecture [23, 26, 27]. The second ingredient is a peculiar class of categories named the Kleisli categories [36, 37]. They are required to assure the construction of a limit for the multiplicative monoïd and hence to achieve a compactification of the class of inductive functors into a multiplicative final algebra.

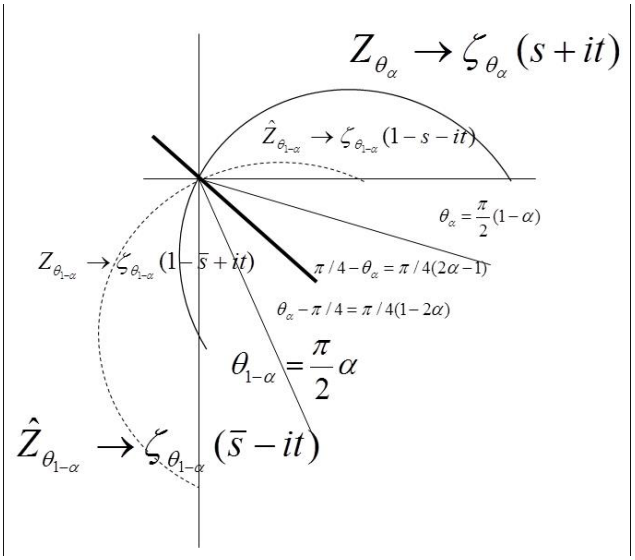


Figure 5. Yonesda basis of zeta Riemann function through Cole et Cole transfer function. This diagram highlights the role of phase angle. The shift of angle with respect to the sign of the rotation founds the relationships with non commutative geometry [5,27].

4.1. Yoneda Lemma

This lemma is related to the embedding of a small category into the category of functors [22]. The objects are identified with the field of representable functors, and the internal morphisms associated with all natural transformations between these functors. It is a vast generalization of Cayley's theorem for groups (seen as small categories with a single object). In other words, if a class of functor is reduced to the different point of views $@\zeta_{\theta_\alpha}(s)$ upon the object, – herein Figure 5 –, the operator @ give its address through the rotation $\pm it_{\theta_\alpha}$ – defined with a phase angle θ_α – Yoneda lemma asserts that the description of an object is equivalent to give the set of all adresses related to the object, as well as their mutual transformations. In practice, the Yoneda lemma justifies the role we have assigned to Cole and Cole canonical transfer functions, like basis (in fact categorical co-limit) of the representation of all possible perspectives (functors) upon $\zeta_{\theta_\alpha}(s)$ parameterized with $\pm it_{\theta_\alpha}$, with the imperative condition of using a relevant tuning factor given by the right phase angle. At this step, our arguing should join another point of view able to be built from Connes noncommutative geometry [5]; in simple words: *the*

commutation change the phase. But we know starting from all the studies developed upon non integer differential equations that the geometrical basis of the role of the phase angle is none less than the existence of an underlying self-similarity characterizing jointly the Cole and Cole transfer functions, the fractal geometry of the interface of physical transfer in the fourier space, and the path integral upon this fractal geometry [27]. The measure of this path integral upon the dynamics is precisely related to the Riemann zeta function. The problematic is summarized in figure 5 and it is extendable to the functional relationships characterizing the class of functions zeta, according to the bijection established between both following sets $[Z_{\theta_\alpha}(\omega\tau)\ Z_{\theta_{1-\alpha}}(\omega\tau)\ Z_{-\theta_\alpha}(\omega\tau)\ \zeta_{\theta_{\alpha-1}}(\omega\tau)]$ and $[\zeta_{\theta_\alpha}(s)\ \zeta_{\theta_{1-\alpha}}(s)\ \zeta_{\theta_\alpha}(\bar{s})\ \zeta_{\theta_{1-\alpha}}(\bar{s})]$. Of particular note: (i) *nonobstant* the presence or the absence of a physical meaning of both parts of the Cole and Cole diagram, the number n in the expression of a dynamics (abstract or real), gives equivalently the meaning of both hyperbolic lengths linking the three limits, $[0,\infty_+,\infty_-]$ of the dynamic diagrams. Hence, the functional relations between the transfer functions must have their equivalences in the functional relationships upon zeta; (*ii*) the alpha phase angle is an element among others of the problem raised by the Riemann hypothesis, but this element is fundamental because, it determines the relevance of the Yoneda lemma for this problematic. It is indeed the only factor that sets the real part of the power law, therefore the phase required for the definition of the rotation given by the factor $\pm it_{\theta_\alpha}$ and hence a détermination without any ambiguity of the morphisms $Z_{\theta_\alpha} \to \zeta_{\theta_\alpha}(s+it)$; (*iii*) the functional perspectives established on the transfer functions and therefore upon zeta functions allows us to understand the depthness of Riemann's hypothesis – in term of commutative singularity in the framework of non-commutative geometry – that imposes $\alpha = 1/2$ and hence the value for the phase angle: $\theta_\alpha = \pi/4,$ some kind of Zeeman condensation. Highlighting the role of primes, this strong constraint involves the disappearance of the entropic factor and a return to a reversible temporality that is to say, to the main condition of existence of 'objects of science' (invariant or stationary state) with respect to standard experimentation.

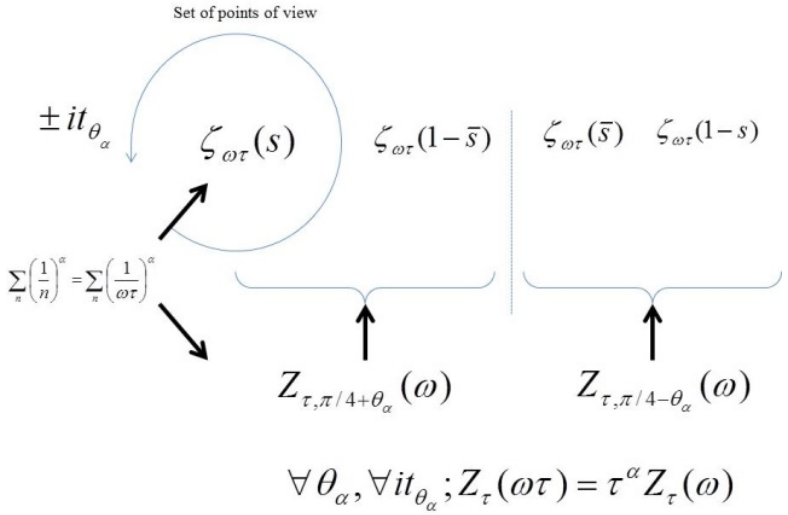


Figure 6. Schematic representation of the relationships betwwen fractional Cole and Cole transfer function and zeta Riemann fonction emphasing the role of the phase angle with respect to the sign of the rotation.

This singular behaviour is justified because it must exist the link between the zeros of the zeta function, and the universal properties of steady states such as those pointed in quantum mechanics [12]. However, the issue concerning the properties of 'complex systems' is more complicated than the one given by the zeros-spectrum. It is more precisely the following: "*what can we tell about the physic of the pseudo-states, located aside the stable states, that is to say, aside of the zeros?*"

At this stage the concepts of monads, of Kan extension and the ones of Kleisli categories play a fundamental role in terms of understanding the Riemann hypothesis in the framework of a more general level of analysis of the complexity. For instance, the Kleisli categories highlight the reason of the transition between the reversible time and the irreversible time; the deepness of the meaning of the decoherence process when changing the coarse graining for zooming upon a complex object. This is rather well known in quantum mechanics, but many other classes of macro-systems, named 'zeta complex systems' by the authors [28], feature the same type of properties, and among them, the econometric systems.

4.2. Kleilsi categories and Kan Extension

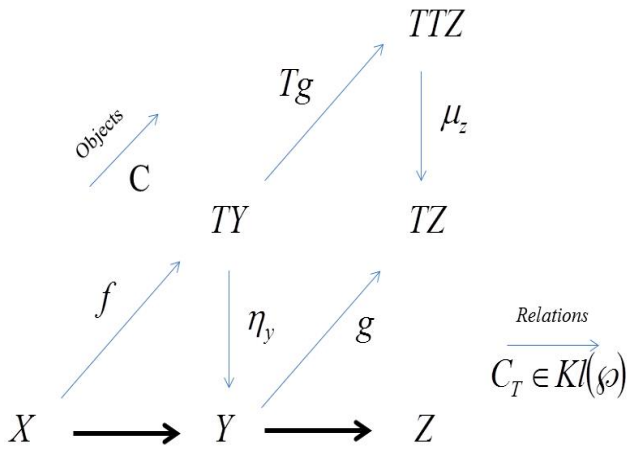


Figure 7. Relationships between Kleisli categories and natural monad $C(T,\eta,\mu)$. The monad is characterized by basic internal relations between internal states that establish both identity and local closure. The relationship with other monads gives rise to a geometry of relations.

As has been seen above, the validation of the Voronin theorem requires the compactification of the multiplicative monoid $(N\times)$ in order to have at disposal a limit, before any folding down this limit upon the natural co-limit of the additive monoid $(N+)$. The conceptual difficulty is that the algebra associated with the multiplicative monoid has no final algebra that means that there is not any limit without an additional mathematical transformation, precisely called compactification. But this operation is far from trivial. However, the authors argue that the compactification can be obtained using a monadic 'projection' upon Kleisli categories $Kl(\wp)$, that is to say, upon a category only concerned by relations, as shown in figure 7 and 8. Recall that all category of relations C_T is a Kleisli category and that it is almost always linkable to a monad $C(T,\eta,\mu)$. The monad plays the role of categorical limit. If we add that we may describe the compactification in terms of adjunction (Figure 8), the aim of our approach is then reached, and a limit of multiplicative monoid is found.

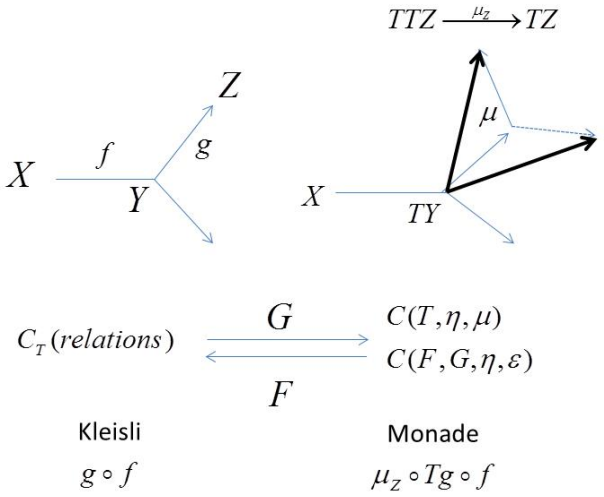


Figure 8. Diagram that highlights how the relationship between Kleisli categories and natural monad and bases the emergence of the renormalization group through the loop of self coherence.

More precisely, Given the monad is defined by $C(F,G,\eta,\varepsilon)$, with $F:C\to C_T;\ G:C_T\to C;\ \varepsilon_Y=1_{TY};\ \eta_{TX}=1_X$ then the Kliesli categories are defined from an entanglement of the morphisms through the fonctorial relation, between C the category of monad *and* C_T the categories of relations. In the frame of group theory, the approach appears perfectly focused upon the limit because as shown in the diagram above (Figure 8), the monadic adjunction requires the existence of a basic pattern, the folding down of the multiplicative pattern on the monadic pattern causing a natural emergence of the generator of a renormalisation group. Let us also observe that the monadic adjunction applies to the transfer functions (Figure 9) where it expresses a morphism concerning the functional relationship. Indeed, we notice herein that the categorical adjunction is at the foundation of the relationship between $Z_{\theta_\alpha}(\omega\tau)$ and $Z_{\theta_{1-\alpha}}(\omega\tau)$, the disjunct sum '*Z*' being viewed as a virtual transfer function based upon a Kan extension $Z_{\theta_\alpha}(\omega\tau)$ along $Z_{\theta_{1-\alpha}}(\omega\tau)$. According to our above arguing; this extension is the basis of the functional relationship well known for the zeta functions. It is in fact possible to create the extension to ensure that Ran *Z* is a functor likely to switch the parametrization orientation. The transfer functions $Z_{\theta_\alpha}(\omega\tau)$, $Z_{\theta_{1-\alpha}}(\omega\tau)$ are indeed the result of a combination of injection points of $Z_{\theta_\alpha}(\omega\tau)$ upon $Z_{\theta_{1-\alpha}}(\omega\tau)$ the inverse

injection insuring not only the commutation (*RanZ=LanZ*), but also, according to the Yoneda Lemma, a functorial link leading the symmetry between *s* and 1-*s* in the relationship: $\zeta(s) = 2^s \pi^{1-s} \sin\left(\frac{\pi s}{2}\right)\Gamma((1-s)\zeta(1-s)$ with $s \in C \backslash \{1\}$ Since there is a structural connection between Kan extension and Fourier transformation, it is confirmed that the functional $\zeta(s)$ equation finds its origin in the existence of a set of eigenfunctions of the Fourier transform of zeta into the certain class of $L^2(R)$ functions. Practically, the entanglement -untied via the Kleisli categories and an unfolded by using the coincidence of the additive and multiplicative monoïds-, involves not only the emergence of a renormalisation group, but also the emergence of a functional relation between $\zeta(s)$ *et* $\zeta(1-s)$. This physical meaning of this relation is remind via the Figure 9.

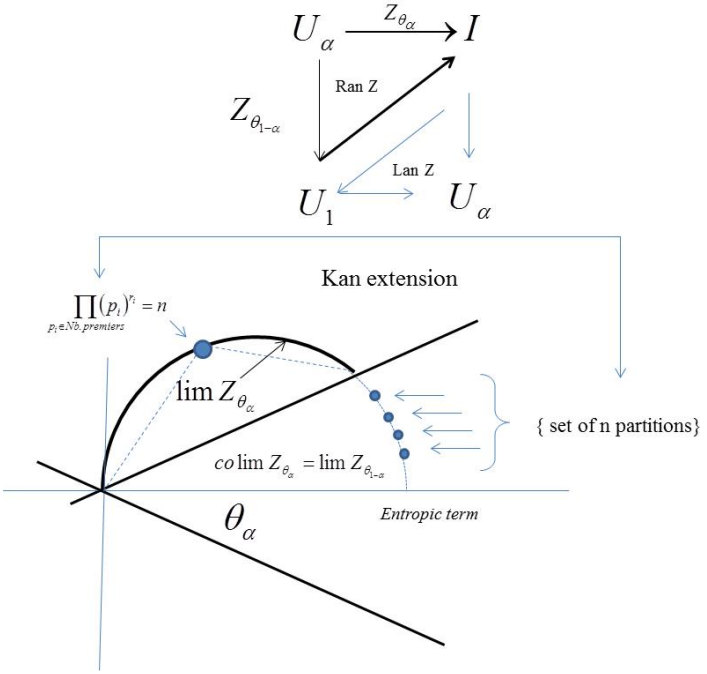


Figure 9. How the commutative Kan extension highlights the irreversible time component when analysed through the Cole et Cole transfer functions. This specific source of irreversibility was first experimentally disclosed 35 years ago [24].

All this issues will be considered in detail in future mathematical publications [37].

5. Consequences in econo-physics and monetary theory

As we noted above, the categorical approach of the Riemann hypothesis allows to understand the following major idea: *out of the field of existence of the non-trivial zeros (Primary steady states), – that is to say out of the field of a deterministic symmetric imposed by* $\alpha = 1/2$ *and* $\theta_{1/2} = \pi/4$ *with* $\zeta_{-\pi/4}(s) = \zeta_{\pi/4}(\bar{s})$ *– the Riemann zeta function leads one to think the fractional dynamic systems and more generally the complex systems -and/or the auto-organized systems-, like couples of dual and asymmetrical components*. The emergence of the duality is due to a non commutativity of the geometry of the dynamics that is to say, the presence of a different phase angle for both sign of rotation (+,–) in other words time singularities at boundaries. In the complex environment, any irreversible dynamics must be divided into two parts (disjoint but able to be adjonct), into two reciprocal categorical 'extensions' leading both projection and surjection. Specifically, one of the components of our representation concerns a geodesic of action and/or relations, parameterized by a frequency, that is to say the coarse graining of the dynamic groups, while the second component relates the distribution of the Fourier transform (the above parameters), onto discret normalized degree of freedom (time constant). This splitting imposes an almost general irreversibility of the processing (to create a relation is obviously not the inverse of cutting it). At this step, the nature of the irreversibility has still to be defined, but sole the couple allows retrieving symmetry through the ability of switching inductive and projective diagrams. In spite of the entanglement of both components, the duality allows to find a combinatorial form of causality and steadyness. We train the assumption that the coupling of both components is a general principle to illuminate complex behaviours. As asserted Clement Rosset [38], for being relevant, we must always consider the real and its shade. From this point of view, the thinking of complexity is moving away of a functional vision (like physical or pure numerical model) for coming close a functorial vision (research of homeomorphic folded upon boundary structures). It is in this context that should probably be revisited what we call 'econo-physics'.

But, in economy, the critical posture is quite difficult [13]. The econo-physics is based on the following idea: the objects of economical exchanges are considered like 'scientific substance', because they have a tangible reality. In this framework, and out of any social considerations, the scientist paradigms want their behaviour must follow some 'natural laws'. They must be searched and found. But the majority of neoclassical concepts appear epistemologically too simplistic with respect to the

complexity of the global economy. Maurice Allais at the end of his life like Steve Keen [18] or Gael Girault, doubt of the truth of this point of view even though it represents the main stream of econometrics and monetary studies [10]. The economic crisis and their resolution show that natural laws are in fact social rules. Like the aghast economists, we also doubt of the trueness of the axioms of the standard econometry (too close to physics concepts), and obviously, of its conclusions (too close to equilibrium thermodynamics point of view). This is particularly the case of the assumed separation between physical capital and intangible capital. What makes emergente the 'beings for the exchange' is none other than its social value or the 'price', in the broad meaning of both intangible and macroscopic, that is to say: social and symbolic [18]. There is clearly an irreducible duality between the social value of an economic entity and its existence as part of exchange. The relationships between entities are not even nonlinear, but combinatorial and entangled because they are part of a symbolic whole. Moreover, even if the exchanging laws are simple to express, ("it is bit" or "bit is it"), they no less create the emergence of a great multiplicity of complex structures, markets, whose erratic behaviours certainly does depend neither of the action of an invisible hand nor of a perfect competition, - finding their sources into quasi-thermodynamic point of view. Indeed, the presence of States, monopolies or insiders exclude the efficiency of the performative ideal-scheme even if it is certainly convenient for computing abstract models, or for publishing academics notes.

To sum up, the authors think that we are still very far from an 'econo-physics' that would be able to be regarded as a science, that is to say, as a field of treatment of 'objects of science'; outside of any social symbolic representation. However, that skepticism must not suppress the certitude of a real need for a rational relation to the complex systems (living systems, social systems catastrophic systems, economic world, etc) based upon physical analysis. The 'econo-physics' is a part of a broader problem, that of rationalizing the complexity, seen like an entangled system of relationships and exchanges. Both require an understanding effort based upon very similar formal will. The above analysis suggests that a complex object, as exchange structure, is the component of a class of 'uncompleted scientific objects'. No simple causality, may explain their behaviours. Nevertheless, the field of existence of such ‘tempo-beings’ can be understood using some general rules of category theory. The rules concerning the morphisms are able to highlight some internal degree of freedom, always balanced by some internal symmetry characterizing the

duality. By reaching the limits, these relationships are able to lead compactification achievements, Kan extensions, and forcing [4]. The duality that leads to an extended causality and forced steadiness is based upon the closure between what is accounted (flow, cash and stock) depending of a projective computation $(N+)$ and what is measured (price, savings rates,...), that is dependent of an inductive computation $(N\times)$. In the classical theory, this interaction is hidden into both Exp and Log functions giving rise to temperature and time constant concepts. The matching between both monoids for computing does not lead to reproducible universal laws like in physics because it does not give birth to a 'scientific object' and because the resulting algebras are neither incremental nor linear in the space (projective) and in the time (surjective). The matching gives birth to distributions of fractal set of singularities, partly defined from environmental variables. They veil the internal variables into a fog of uncertainties when course grained. Naturally open, these systems do not possess any imanente categorical limits. They have to be constructed. However, as it has been seen concerning the resolution of the Riemann hypothesis, a duality can be built in suitable fields of interactions to rebuild an over-structural causality, involving the environment as a categorical limit of the complex object. Among the specific spaces that are able to help to formalization exists a new class of causality based upon duality that we can consider in the space Υ of primes suggested above [36].

To illustrate the proposal one can analyse for instance, the axioms of monetarism that consider the currency as the alpha and the omega of the economy [10]. The monetarism aims an adjusted monetary injection, to reach a 'steady state' of the economic system. It artificially distinguishes two components: currency and goods , both being combined stochastically for giving to the economy a stationary state of growing, for instance 5%, defined from outside institutions. The behaviour of economy should then match a deterministic behaviour, Z. In this frame, the anticipation of the economic growth defines the rate of interest of the currency supply, while the economic balance is achieved through the fluctuation of the interest rates around a fantasized fair value. This fair value only exists if the system matches the field of the zeros of the Riemann function that is to say in the neoclassical theory if the full employement is reached at each level of the economy. Within the formal framework outlined by our analysis, the omniscience of the market and its infinite speed of adjustment between coupled variables lead the pattern given of the figure 10 where money is a mirror of the transactions.

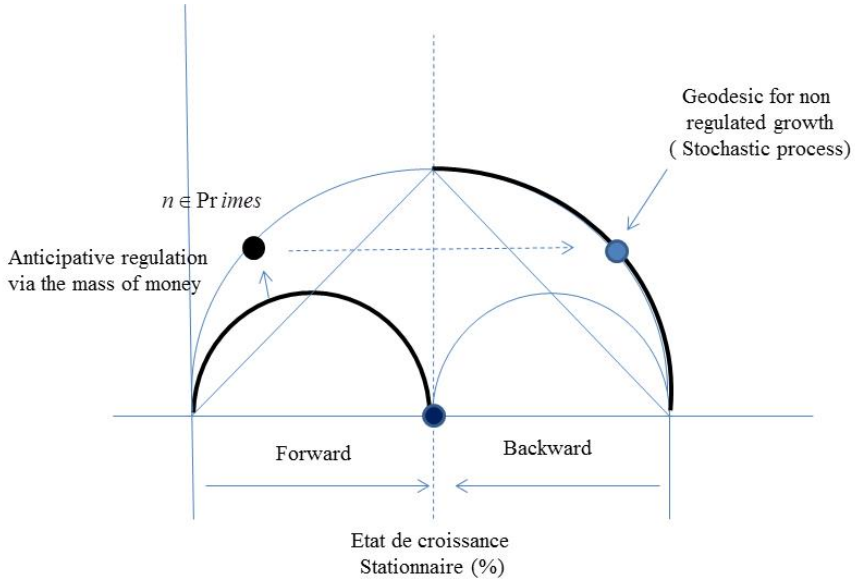


Figure 10. Riemann hypothesis situation analysed from the adjunction of a couple of random 2D Cole and Cole diagrams into a first order *Z* spectral representation. This mirror situation is implicitly asummed by the neoclassical theory.

According to this scheme, the unclosed economy is pinned on a 2D hyperbolic geodesic, which has for basis only the chance and not any environment. The stochastic market, in fact the banks, as actors replace the state to produce symbolic value. The variables of anticipation and / or projection of the economy into the future, based upon the currency supply, are folded upon the monetary geodesic. The economy is no more than a casino-economy. Monetary policy and economy are coupled via the set of primes without any freedom. As shown in figure 10 above the symmetry is total. The dynamics of the economy is then clearly determined by the sole monetary growth rate [10]. The hyperbolic morphism between both components merges the dynamics onto a geodesic of a global economy (trading in goods, added with the trading in currencies) matching a simple first order system *Z* (Newton type equation), indeed implicitly a very simple causal system herein based upon a splitting of *Z* into two random symmetrical geodesic. The dictatorship of the market is assured. The monetarists claim that the global dynamics would then be optimal. But what kind of optimality is concerned? If we use the Nash embedding theorem – that establishes the existence of an isomorphism between any hyperbolic manifold and a Euclidean space – to project the process in adapted spaces, we can show (Figure 10) that the distributions do not interferes together. In fact the monetarism is not concerned by the real

economy. It is a platonic ideology in terms of values and and ideal type of performative device, in terms of governance ! Without any consideration of the being it is a performative ideal template used to impose a self realizing prediction written within a fight for individual utility. However, this ideology possesses a unanswerable quality, we wish to emphasize: in the purely 2D random case (in fig 10, the phase angle is strictly equal to $\pm\pi/4$), the pure market is said efficient; it emerges from a symmetrical construction that reduces the general problem which involves a symmetry in the set $Z_{\theta_\alpha}(\omega\tau)$ vs $Z_{\theta_{1-\alpha}}(\omega\tau)$ / $\zeta_{\theta_\alpha}(s)$ vs $\zeta_{\theta_{1-\alpha}}(s)$ that is to say, it asserts the existence of steady states (or stationary) obviously singular and isolated in an abstract space. The monetary model hence implicitly assumes the existence of a reversible time variable. In other words, while pointing the relevance of the couple currency / economy as the basic element of the economy, monetarism gives a simplistic vision clearly not suited to understand what a complex system is, but that can be extended. In spite of its simplicity, the monetarist perspective, has a virtue, it allows considering an unlarged case to the modern monetary theory based upon money seen as a Kan extension of the real economic exchanges.

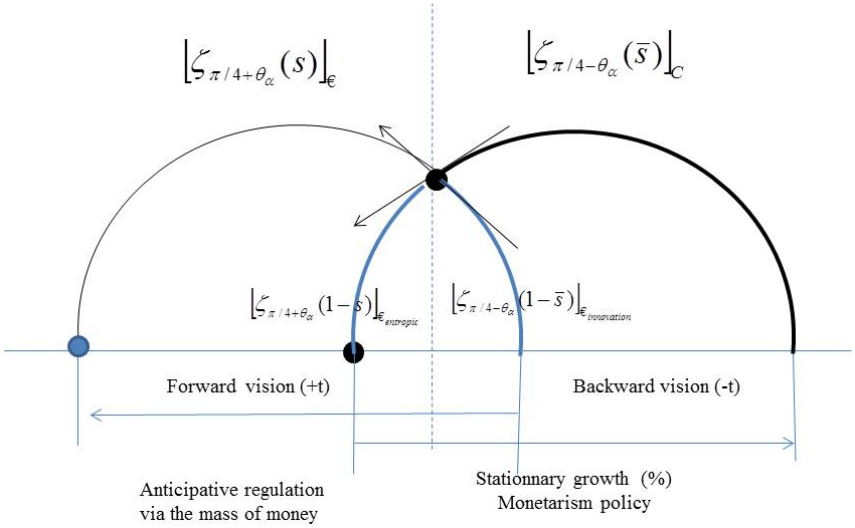


Figure 11. Diagram that highlights the duality between active backward economic and forward monetary visions. The Figure 10 is simply a degenerate form of this diagram.

If this hypothesis is relevant, the theoretical analysis that led to a new approach to the resolution of the Riemann hypothesis can be of a great help, especially for understanding why in economy, the financial field

plays a very similar role to the entropy/negentropy factor in physics. By considering some properties related to the general case – not solely focussed upon stationary states –, the monetary point of view may be enlarged to point in the direction of Modern Monetary Theory, without any exclusion of the existence of an optimal prospective geodesic (Figure 11). In this case, money may express the symbolic correlations established in the dynamic social structure of exchanges which behavior is partially condensed through the concept of phase angle, that is to say, through the factor of non-commutativity of the dynamics, in other words, through a noncommutative manifold

6. Discussion

According to the above analysis, the steering control of the economy using currency is always possible, but in the above enlarged framework, this control has to take into account the correlations that characterize the dual structure of the economy. In addition, the field of interactions between prospective point of view, and inductive point of view has to be perfectly mastered. In an asymmetrical fluid exchange state – between goods and currency –, mainly unstable, the currency, – seen like an entropic extension-, aims to combine a dynamic state of the real economy represented here by $Z_{\theta_\alpha}(\omega\tau)$ or $\zeta_{\theta\theta_\alpha}(s)$ with a 'virtual stabiliser' always prospective. This prospective component is herein expressed through $Z_{\theta_{1-\alpha}}(\omega\tau)$ or $\zeta_{\theta_{1-\alpha}}(s)$. Therefore:

- The currency expresses a confidence in a representable future new stable state. The geodesics to this state must be seen as a catenation of two fractional stochastic branches characterized by internal correlations serving as dynamical reference. The future, designed from these geodesics, is seen as an opportunity and a calling for investments. In the language developed above, despite the underlying complexity and the stochastic character of the projection to the future, the coherence of the dynamics is perceived at all scales of the processing. While staying in the instability, it is possible to stage the future by the mean of a Kan extension of the existing, upon dreaming states. A collective investment associated with the creation of assets is herein used to change the time constant of action while strengthening the stability of the overall dynamics. The social trust can jointly be increase. This stabilization is provided by money creation assigned to precise investments.

This creation is seen like the change of a stock of currency upon a fractional probabilistic set and not through the credit. The extension is seen as a modification of the economic action itself. In this frame, the value of the currency and thus the rate of interest reflects the overall expansion of the dynamic, that is to say, the confidence that the society places within the future.

- This projection is essentially composite, because, as shown in the model, it gives the distribution of all the time constants of acts that can be considered inside the real economy. Practically, there are many ways to distribute the currency upon a sole optimal geodesic. The key for coherence is here the conservation of the correlations that allows the maintenance of the social trust, registered into the internal correlation field (herein the phase angle).
- The phase angle defines precisely the internal correlations of the complex system. Therefore it defines the coherence of the economic structure and the meaning of the collective dynamics toward the future. As we seen, if exchanges are left to the free market fluctuations, only constrained by the amount of currencies, even mathematically optimal, the system is no more socially ruled because the monetary structure, constraint by the random distribution of primes, can no longer be composite. Human being becomes particle. The chance is hence the sole engine for a development only based upon the strong hierarchy of a society without any exteriority. Due to the symmetry, the market is finally left to the financial monopoles and the prices are defined by them (that means lower prices and salaries and higher incomes for the gentry). That is the well known social limit of the monetarist choices! At the opposite, if the market is fully regulated in a deterministic way, currency is no longer required and exchange becomes barter. Any pure dictatorial model has to face this limit.

This analysis leads to a certainty: our ability of re-enchantment of the world is located in an in-between always unstable but where the money plays the role of symbolic social stabilizator. This positioning is based upon an incompleteness of our 'numerical' representation of the real, and upon a duality of the reality always designed like an uncompleted motion. The incompleteness must be partially filled with tools that we put in place to answer to the questions addressed by our imagination. As shown above, these tools have both symbolic and operational status; symbolic because they reflect the internal consistency of collective dynamics; operational because it is mediated by investments for a common future. These

investissements are called 'assets' in economy. In this context the time coupled to the action is clearly irreversible because it is associated with some kind of confusion between the real able to be compute and the virtual. This aspect disappears in the monetarist framework. The difference between these two temporalities reversible and irreversible is not only related to the functionality of tools but always linked to a measure of distance, but it is a hyperbolic distance (here given using the phase angle) involving singular behavior at boundaries. It is in this frame and taking a position opposite to the modern newtonians asserting that 'time does not exist', that Lee Smolin asserts the time as one of the key variables of future physics [40]. Conversely, if the world is plunged into the stream of irreversible time – as assumed by Smolin and Connes –, this irreversible time flow necessarily induces correlations at all levels of complexity and thus justifies the duality of uncertainties. Therefore the phylogenetic evolution becomes natural. We then understand what the cognitivists call with Francisco Varela 'embodied cognition' translated in french by the word 'énaction', where the language unveil the idea of action as a pivot of prospective toward future and the idea of free correlations between both action and dream. We find again herein the idea of the Spanish writer Antonio Machado that the trail is always draw by the walker (*Caminente no hay camino, se camino al andar*).

7. Conclusion

As noted in the book published under the provocative title: 'The trouble with physics', Lee Smolin criticizes the Newtonian and Cartesian attitude, which, far from the complex systems analysis, bases the physical models upon the concept of computation upon 'scientific objects'. Smolin expresses a critic of the paradigm that separates body and mind and organization and its reasons. This splitting is less and less adapted to the complex reality to which we have to face. The modern crisis of the Euro is a perfect example of what happens if the symbolic social role of the money is forgotten. The duality of economy and finance is only a particular mathematical category of complexity. Facing this complexity, it is very difficult to build new models because our education is patterned by paradigms of single and simple causality without any feedback. Nevertheless, henceforth, the categorical concepts allow us to think the limits and the duality of objects that cannot be reduced to points or numbers. In this frame, the monetary policy may be considered as being the initial algebra with respect to a co algebraic economy, seen as final co

algebra of endofunctors into a social set. Thinking an econo-physics on the basis of current physics is to ignore, at least partially, the current conceptual limitations of this science. The epistemological assumptions which built and justified the concept of 'objects of science' (eternal, reproducible, able to be falsified, etc) cannot be neglected at this stage of our reflexion. There is no doubt than, with the sole reference to physical paradigms, our mind traps itself in an unspoken jail from which it will be not so simple to escape. Faced with this difficulty we propose to follow an aside trail, by observing that the economy is just a peculiar field of issues in the frame of more general complex systems. Far from classical physic, the main issues are related, (*i*) to the rôle of singularities, (*ii*) to absence of falsifiability, (*iii*) to the requirements of simulations, (*iv*) to the rôle of environmental variables, (*v*) to the treatment of 'big data', etc, all questions being outside the field of traditional sciences. Hence, the emergence of the idea of extending the concept of rationality and call 'Sciance', with 'a' [42] the design of adapted dual rationality. Also emerges the idea of calling 'Zeit Objekt' [Husserl] the object of study of complex systems. At this step, it is only a moot intention nevertheless the practical scope of the categorical first approach of the resolution of Riemann hypothesis herein delivered, is a fundamental reason for going in this direction. Indeed this approach takes the status of a Swiss Army Knife for the hiker in the wild landscape of complex systems. What is telling through this approach is mainly that pure physical state is an extremely singular situation and that our representation of the world must be dual. The traditional 'object of science' contains an artificial temporal symmetry, the projection into the future, being identical to the projection into the past. In the general case our representation of the world can not be so simple, that why, except in very simple cases, the 'Object of Science' must be revisited for leaving the way to a 'Zeit Objekt'. The internal self-similarity of this new 'objekt' of Sciance' must be of algebraic essence; the irreversibility must be the foundation of its open internal dynamics, and the ultrametric its fundamental metric. That is why we propose to leave aside the concept of 'econo-physics'. The ontological crisis of the post modern physics should no longer be transfered in vivo econo-physics issues. We suggest calling 'econology' the Sciance of the economic systems, henceforth considered as a part of the Sciance of Complex Systems.

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ECONOBOTICS – A NEW FRAMEWORK FOR THE ENTERPRISES DEVELOPMENT

Ioana ARMAŞ*

Abstract. *In the present paper a new scientific field regarding the development, design and management of the modern enterprises, namely* ***econobotics*** *is considered.*
The fundamental concepts of the domain are: the econobotics or competitiveness space, the econobotic problems, and the econobotic systems, that are introduced and defined in a synergistic integrated context.
Based on these definitions the framework for the design and development of the enterprises as econobotic systems is constructed, and also other econobotic systems are identified.
The results determine the scientific area of econobotics as the context for future enterprise's design, development and management from a new perspective of heterogeneous evolution that may lead to positive mutations in creating a global adaptive and intelligent context compatible to the future processes and phenomena induced by globalization.

Keywords: *econobotics, econobotic problems, econobotic systems, intelligent enterprises, competitiveness, enterprises management, complexity.*

1. Introduction

Enterprises represent complex systems created and developed by humans in the extended competitiveness environment. Their evolution conducted to specific basic functions and generated knowledge and experience that determined corresponding scientific fields for modeling, simulation, design, and development of the enterprise and their external and internal environments.

Recently, econophysics and complexity sciences became domains that identify and model the corresponding laws for economic simulation, process understanding, enterprise's behaviour, based upon the large area of physics and mathematics.

In this context, the present paper considers and defines the scientific area of ***econobotics*** in order to model, simulate, design, develop, and

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manage the enterprises and their environments in the econobotic / competitiveness space.

Econobotics will consider the enterprise as a complex and heterogeneous system able to solve specific problems – econobotic problems.

The definitions of econobotics, econobotic problems, econobotic systems will be established, and accordingly the design and development framework for creating new enterprises as econobotic systems in the competitiveness world will be obtained.

2. The econobotic / competitiveness space

Considering the competitiveness representation as in figure 1 [1], results that a three dimensional (3–D) space can be defined by wrapping the dimensions and parameters attached to the enterprises' reality and evolutions into the following three global dimensions:

- ***the technical dimension,*** *T*, corresponding to the offered products and services, and the processes attached to them according to their life-cycle. technology etc.;
- ***the social dimension,*** *S*, corresponding to the humans – users or not, society, natural environment etc.;
- ***the economic dimension,*** *E*, corresponding to the economic aspects, finances, costs, profits, etc.

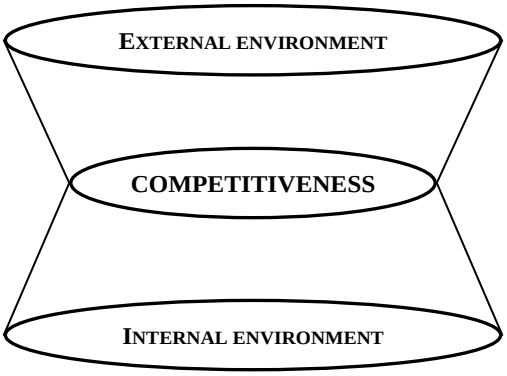


Figure 1. [1] The competitiveness representation as the interface between the external and internal environments of an enterprise.

Thus, the econobotic / competitiveness space is determined by the *T*, *S*, *E* dimensions and will be represented (fig. 2) by the model of reference system $OTSE = \{0\}$ regarding to which all the econobotic systems,

including the enterprises, and the components of their internal and external environments will be represented. The econobotic / competitiveness space will be denoted as the *TSE* space.

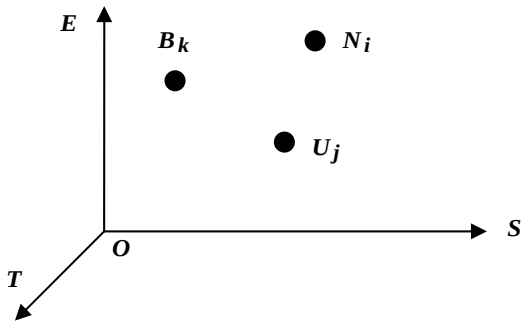


Figure 2. The econobotic / competitiveness space: N_i – enterprises and other econobotic systems; B_k – products and services on the market; U_j – resources and other econobotic objects.

3. Econobotics – definition and context

Econobotics is a modeling, simulation and development framework that represents the use of the enterprise's capabilities in performing modifications of the competitiveness environment through actions and evolutions based upon information acquisition, processing and decision.

Observation. The competitiveness environment and its configurations will be represented in the econobotic / competitiveness space of figure 2.

Thus, econobotics represents:

- an open and heterogeneous scientific area in the development and management of the enterprises;
- a management strategy applied for the optimal design, development and evolution of the modern enterprises;
- a complex solution for flexibility, adaptability, effectiveness, quality, and intelligent capabilities of the enterprises, based upon the competitiveness objectives and representations;
- a systemic representation of the enterprises and their environment in a specific space (i.e., the econobotic / competitiveness space, the *TSE* space);
- a synergistic integration of different scientific, engineering, economic, social, etc. domains, in order to develop complex and heterogeneous models for the enterprises.

In these conditions, ***econobotics*** represents the multidimensional and multifunctional technological context of developing solutions for the

design of the enterprises together with their corresponding processes, such that they are able to develop the competitiveness reality through perceptions, decisions, and actions / evolutions in and/or upon the *TSE* space corresponding to their environment.

4. Econobotic problems and econobotic systems

The main concept in developing an enterprise according to the econobotics framework is the ***econobotic problem*** that must be determined and specified in order to further determine its conceptual solution as the ***econobotic applications.***

Definition* 1.** Let be $C_i = C(t_i)$ a configuration in the *TSE* space and $C_k = C(t_k > t_i)$ a goal configuration in the same space, if the transition $C_i = C(t_i) \to C_k = C(t_k > t_i)$ is obtained through actions in and/or upon the environment in an interaction context with the reality through perceptions and decisions, than $C_i = C(t_i) \to C_k = C(t_k > t_i)$ is an ***econobotic problem.

Considering definition 1, the following types of econobotic problems are presented below:

1. *The navigation problem* (fig. 3) is determined by the configurations: $C_i = C(t_i)$ representing the current position of the enterprise in the *TSE* space, and $C_k = C(t_k > t_i)$ – the goal configuration to be attained. The transition $C_i = C(t_i) \to C_k = C(t_k > t_i)$ realization implies actions in the *TSE* space, such that the goal is attained by interactions with the reality through perceptive information regarding the environment, and decisions relatively to the types of actions, and plan of action.

Thus, the navigation problem is an econobotic one.

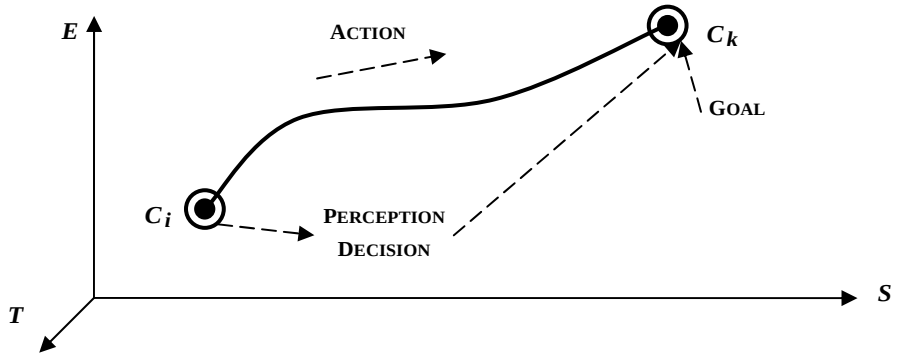


Figure 3. The navigation problem.

2. *The tracking problem* (fig. 4) is described by the following components: N_1 – the enterprise representing competition for N_1; $\Gamma_1 = \Gamma_1(t)$ – the determined, predicted or estimated trajectory of N_1 in the *TSE* space; N_2 – the current enterprise; $\Gamma_2 = \Gamma_{2t}(t)$ – the tracking trajectory of N_2 in competition in the *TSE* space.

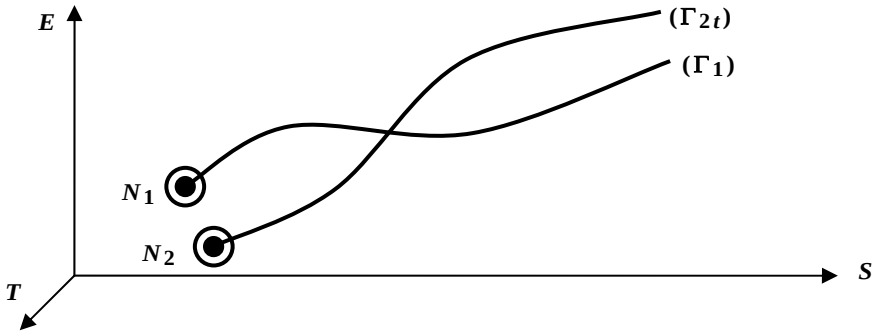


Figure 4. The tracking problem.

The corresponding configurations for figure 4 are $C_i = C(t_i) = \Gamma_1(t)$, and $C_k = C(t_k > t_i) = (\Gamma_1(t), \Gamma_{2t}(t))$, such that the solution of the tracking problem $C_i = \Gamma_1(t) \rightarrow C_k = (\Gamma_1(t), \Gamma_{2t}(t))$ implies:

- perceptions regarding N_1 and its evolution $\Gamma_1(t)$;
- decision regarding the actions to be taken by N_2 and the necessary trajectory $\Gamma_{2t}(t)$;
- actions executed by N_2 in the *TSE* space in order to realize the established evolution of N_2, $\Gamma_{2t}(t)$.

Thus, the tracking problem is an econobotic problem.

3. *The fusion problem* (fig. 5) represents an interception of an enterprise N_1 having an evolution $\Gamma_1 = \Gamma_1(t)$ by the enterprise N_2 through a corresponding trajectory $\Gamma_{2i} = \Gamma_{2i}(t)$, such that after the intersection moment t_j, $U(t_j) = \Gamma_{2i}(t_j) \bigcap \Gamma_1(t_j)$, the new generated enterprise N_{1-2} will have the evolution $\Gamma_{1-2} = \Gamma_{1-2}(t)$.

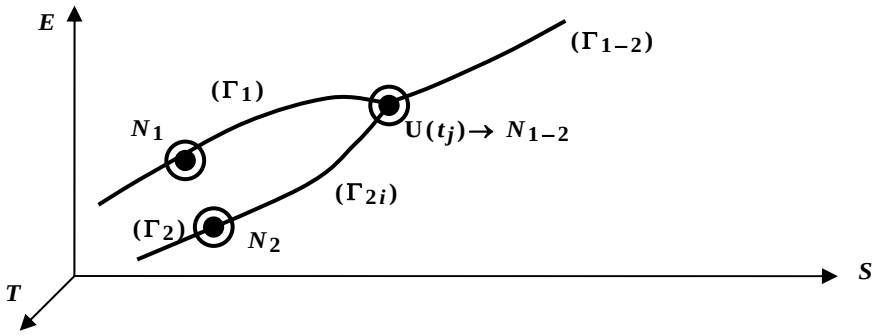


Figure 5. The fusion problem.

The transition to be solved is:

$C_i = C(t_i) = (\Gamma_1(t), \Gamma_2(t)) \rightarrow$

$\rightarrow C_k = C(t_k > t_i) = (\Gamma_{2i}(t)\ ,\ U(t_j) = \Gamma_{2i}(t_j) \bigcap \Gamma_1(t_j) \mapsto N_{1-2}\ ,\ \Gamma_{1-2}(t \mid t \geq t_j))$,

where the solution implies:

- perceptions of N_1 and its evolution $\Gamma_1(t)$;
- decision regarding the interception trajectory $\Gamma_{2i}(t)$, such that at the moment t_j the intersection of fusion is produced: $U(t_j) = \Gamma_{2i}(t_j) \bigcap \Gamma_1(t_j)$ and the reconfiguration of N_1 and N_2 into the new enterprise, N_{1-2} is performed;
- actions in the *TSE* space in order to execute $\Gamma_{2i}(t_j), U(t_j)$, and reconfiguration of N_1 and N_2 into the new organization N_{1-2} with the new evolution $\Gamma_{1-2}(t \mid t \geq t_j)$.

Thus, the fusion problem is an econobotic problem.

At the conceptual level, the solutions for econobotic problems represent ***econobotic applications*** and their implementations are achieved by ***econobotic systems*** that are systems able of perception in the *TSE* space, decide and plan upon the necessary actions to be taken, and perform these actions in and/or upon the corresponding environment in the *TSE* space.

Considering the above conclusions, results that the enterprise is an econobotic system, and accordingly may be designed and developed by identifying the corresponding econobotic problems, and establishing the conceptual solution as the ***econobotic application of the enterprise*** (EAE) that represents the prototype level at which simulations will be performed and the final solution will be validated.

5. Functions and specific processes of the enterprises as econobotic system

Considering the above definitions of the econobotic systems, the following main functions of the enterprise are identified:

- F_1 – perception;
- F_2 – decision;
- F_3 – information and data processing;
- F_4 – actions execution in the *TSE* space;
- F_5 – the competitiveness environment evolution in the *TSE* space;
- F_6 – the human factor behaviour.

In order to solve specific econobotic problems, these functions are synergistically integrated through communication, collaboration, co-working, self-organization, and self-structuring, as in figure 6, where the interaction elements, between $F_1 \div F_6$, $\omega_{ij} = (\varphi_{ij}, \psi_{ji})$, form the informational set:

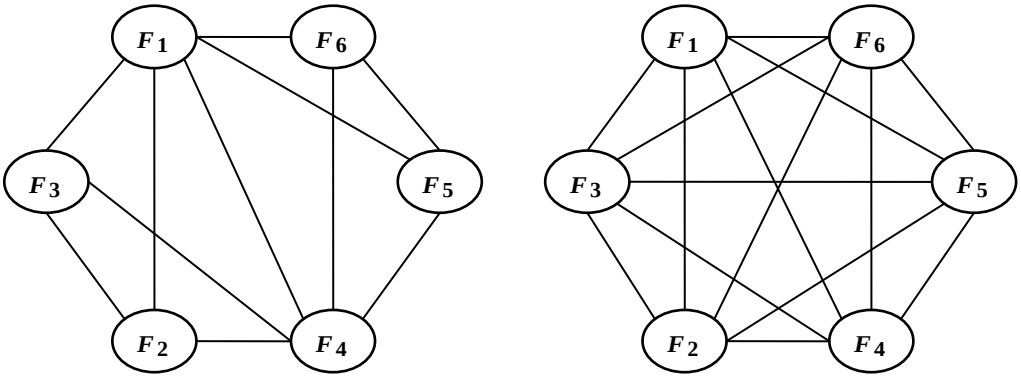
$$I = \omega_{ij} = \{(\varphi_{ij}, \psi_{ji}) : \varphi_{ij} \neq 0, \psi_{ji} \neq 0, \forall i \neq j, i, j = \overline{1,6}; \\ \varphi_{ij} : F_i \mid F_j \to F_j \ ; \ \psi_{ji} : F_j \mid F_i \to F_i\} \tag{1}$$

such that, if one of the functions F_i, $i = \overline{1,6}$ is not performed $(\neg F_i)$, or if I is not formed $(\neg I)$ then the global function of the enterprise as econobotic system is not fulfilled.

In relation (1), $F_\alpha \mid F_\beta$, $\alpha, \beta = i, j$, $\alpha \neq \beta$ represents the set of actions of function F_α in the presence of the set of actions of function F_β.

The necessary condition for self-organization and self-structuring is that each function F_i, $i = \overline{1,6}$ is connected with at least another different function from the set $\{F_1, ..., F_6\}$.

In figure 6 are presented two functional architectures of econobotic systems, applicable to enterprises, according to the previous definition.



(a) (b)

Figure 6. The synergistic functional context of the enterprise as econobotic system: (a) partially connected structure; (b) totally connected structure.
$F_1 \div F_6$ – the functions of the econobotic system.

In these conditions, the following dominant processes of the econobotic systems, and implicitly of the enterprises, are determined as following:

1. ***Environment identification in the TSE space*:** establishes the states and configurations of the environment related to the econobotic problem to be solved.
2. ***Communication with the environment and the human factor in the TSE space*:** data and information transfer between the econobotic system, environment, and human factor in solving the specific econobotic problems.
3. ***Decision*:** determines the necessary actions necessary to be performed in order to solve the econobotic problem, together with their performance specifications, and attains the goal configuration in the *TSE* space.
4. ***Production* / *Solution implementation*:** actions execution and thus effectively solving the econobotic problem.
5. ***Learning and experience accumulation*:** information, data, knowledge and experience integration in structures that can be used later in solving specific or new econobotic problems.
6. ***Control* / *Management*:** tracking and evaluating the specific parameters of actions, and minimize the deviations from their performance specifications imposed by the desired configuration in the *TSE* space.

6. The design framework of the econobotic systems

Due to its complexity, heterogeneity and synergistic integration, econobotic systems will be developed and designed in the framework determined by (fig. 7):

EB1. econobotic problem identification and specification in the *TSE* space;

EB2. development of the econobotic application that represents the solution for the problem determined at EB1, and that consists of the corresponding model of evolution processes and actions that must be performed in the *TSE* space;

EB3. functional design of the econobotic system;

EB4. structural design of the econobotic system;

EB5. global solution simulation and evaluation;

EB6. solution implementation, respectively econobotic system construction;

EB7. econobotic system's dynamic evolution in TSE space and continuous developments.

The main econobotic systems that can be developed according to the framework presented in figure 7 are:

- product oriented enterprises;
- service oriented enterprises;
- human factor in an working environment;
- any organization that generates influences upon the competitiveness environment in the *TSE* space;
- any decisional and acting entity regarding the competitiveness environment in the *TSE* space.

In this context, resources represent objects in the TSE space, upon which the econobotic systems act.

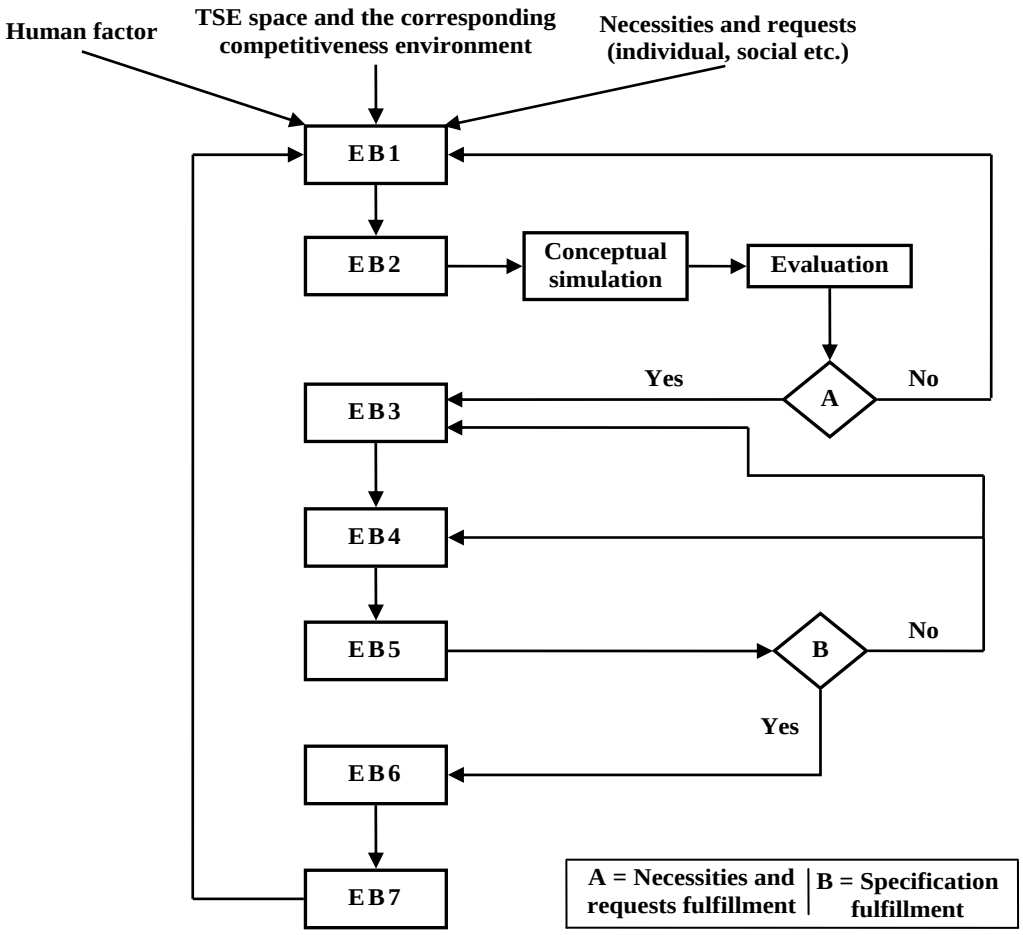


Figure 7. The design framework for the econobotic systems.

7. Conclusions

Econobotics is a new research field considered by the present paper, aimed to model the complex context of competitiveness in which enterprises and other organizations evolve.

From this point of view, econobotics is defined together with its fundamental concepts: the *TSE* space, the econobotic problem, and the econobotic systems.

The enterprises are highlighted as one of the most important type of econobotic systems, and accordingly, the general development and design framework of econobotic systems may be applied in enterprise's development, design and management.

The paper represents the research results in developing integrated models for representing and design the future enterprises in a complex technical, social, and economical space, the *TSE* space.

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STOCK PRICE KINETICS

Rodion REMOROV*

Abstract. *A kinetic model of stock price returns is presented for the description of the stock price dynamics through an impact of the information signals on investor behaviors. The model incorporates behavioral processes of the influence of the private or public information on the exchange of cash and shares flows. Using an analytical approach and simulation technique of the stock prices, we analyze the price rate dynamics for a perfectly competitive market. We show that the stock price is indifferent to the trading volume for the competitive market conditions. The model potentially explains the mechanism of the impact of the information signals on the stock price. The proposed kinetic schemes and analytical approaches may be used for the intraday trading analysis of the stock price dynamics and for the simulation of the hedging strategies.*

Keywords*: stock price dynamics, kinetics, behavioral process, opinion modeling, news impact, semantic analysis.*

1. Introduction

The relationship between the public information and stock price is a key concept of the Efficient Market Hypothesis (EMH). Accepting an idea that stock price incorporates with any new information instantaneously, Samuelson and Fama proposed the Efficient Market Hypothesis in the 1960s [1, 2]. The development of the EMH approach became the consequence of the assumption of the geometric Brownian motion (GBM) of the stock price since 1900's [3], which was a very good model approximation of the stock price dynamics. The GBM model plays an important role in the valuation of the market and credit derivative instruments in the financial industry. Numerous observations showed that the EMH approach works for limited market conditions and the classical EMH framework can't explain the sharp price changes during the financial crisis, for example, the classical "equilibrium" approach of EMH cannot be applicable during financial crisis of 2007-2008 with the large stock price

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decline. The concept of EMH and their modifications are maybe not suitable to study the time-dependence of the stock price.

Considerable efforts have been made by different research groups to develop empirical or fitting statistical methods for the stock price modeling, such as GARCH and AR(1) methods [4, 5]. Application of the autoregression methods may give a useful approach to analyze the some regularities of the stock price returns or the information about the time-scale of the stock price changes. Obviously, the fitting statistical methods can be considered as artificial methods for empirical modeling. The tendency of application of the empirical statistical techniques in the financial industry may lead to the significant losses during financial crises.

The relationship between the stock price change and new information is related to two major problems: how the public information affects on the investor opinions to buy or sell shares and how to measure the investor opinions in the financial market. Recent interesting empirical and theoretical works presented various models of the description of the individual trading behavior that could potentially explain the stock price dynamics. In general, there are two types of information that can be analyzed: public macro/micro-economic news and the information form the exchange trading system. The information from the exchange trading system is used in the both technical analysis and high frequency trading algorithms. Technical analysis is considered by many researches as a non-scientific approach, which is close to human intuition, although some their applications implicitly exhibit the time-dependence functionality. The high frequency trading algorithms apply the information from displayed orders of the book, cancellation, and the execution of the displayed orders [6]. Hasbrouck and Saar reported the observations of the intraday dynamics of the stock prices in millisecond time-scale. The researchers investigated how high-frequency trading algorithms in general may harm or improve the market quality perceived by long-term investors [7]. Their empirical analysis showed that, for some cases, response time to the trading information (from book orders) is comparable with transmission time of the signal between the exchange trading system and brokers.

The dependence of the asset return on the macroeconomic information was intensively investigated by Fisher (1930) in his work of

the "theory interest" [8]. The dependence of the asset return on the macroeconomic information is also related to the time-dependence functionality. Fama and Schwert investigated the relationship between nominal interest rate and inflation using empirical linear regression and they showed that "the nominal real estate return moves in one-one correspondence with both the expected and unexpected components of the inflation rates" [9]. Fama and Schwert concluded [9] that bond market was in complete hedge against expected inflation from linear regression tests with 1-6 monthly lagged periods. Adams et al. showed that large and medium-sized stocks tend to respond to Producer Price Index news in about 15 minutes [10]. Boyd, Hu and Jagannathan applied an empirical fitting of the return against with monthly lagged unemployment rates and growth rates of monthly industrial production to examine how stocks respond to unemployment news [11]. Boyd, Hu and Jagannathan [11] showed that stock prices rise during expansions and fall during contractions with bad labour market news. Pattell and Wolfson [12], Greene and Watts [13], and Gosnell, Keown, and Pinkerton [14] found that stock prices changed within an hour after company-specific news. Lapp and Pearce investigated the impact of economic news of monetary policy on stock price using linear regression fitting with one and two-month lagged data [15].

Various research groups developed theoretical models, which have similarities in chemical kinetics. These theoretical works applied interesting approaches with focus on the investor opinions or behavioral processes. Maldarella, and Pareschi developed kinetic approach for the opinion modeling using the differential equations with density probabilistic functions [16]. Caginalp and Balinovich proposed a model, which incorporated the demand and supply functions through the simple differential equations, for which the supply and demand functions are proportional to the probability k and $1-k,$ respectively [17]. They assumed that the value k is explicitly related to the equilibrium price of the market. Caginalp and Ermentrout demonstrated a kinetic thermodynamic approach to describe the stock price fluctuations [18]. Lux and Marchesi described a multi-agent model of financial markets which shows that scaling arises from mutual interactions of participants [19]. Remorov presented a model for stock price and trading volume during market panic conditions [20]. The model incorporates a mechanism for the share exchange between

buyers and sellers while taking into account their cash balances. According to the model, two types of outstanding shares are considered: actively traded shares in the market and not-actively traded outstanding shares. Three main cash-shares flows can describe the active trading process: the share supply flow for trading (1), exchange flow (2), cash supply flow for trading or demand flow (3). The volume of the actively traded shares defines the stock price through the exchange of cash and shares between market participants. The stock price is defined through the equilibrium between supply and demand flows. The panic market conditions are characterized by the properties of the self-organized market, for which almost all agents have similar expectations for the stock price decline. Using this concept of the herd behavior similarity of investors, it was shown that trading volume is inversely proportional to the square of the stock price:

$$J = R_c \frac{1}{P^2}, \tag{1}$$

where J is the trading volume, P is the stock price, R is the probabilistic parameter, $R_c \approx const$, C is the cash volume in the cash-share cycle. This result is empirically supported in price and volume data for major recent US stock bankruptcies, including Lehman Brothers Inc, Enron, Wachovia, Washington Mutual, and MF Global.

In this paper, we present a kinetic model of stock price formation with focus on the positive and negative information impact and an investor decision to sell or to buy shares. We develop the model of the price dynamics in the context of the application of the ordinary differential equations for the description of the dynamic processes. The motivation of this work is to develop the universal model to describe both the equilibrium market with EMH and the market with sharp price decline taking into account the panic behavioral process through the impact of the public information. We also explain the model limitations and application on the example of the publicly traded shares. Our analysis is based on the direct observation of the relationship between good and bad macroeconomic news. We also demonstrate the application of the kinetic approach for stock price valuation using public macroeconomic news.

2. Data and Preliminary Analysis

Intraday and daily news archives were used for analysis of investor sentiment in the US stock market. We use Bloomberg and Reuters news archives for intraday and daily news analysis, respectively. Intraday public news was recorded from the Bloomberg news archive at 5-minute intervals during the business day. The Reuters news archive was used for the daily news analysis for the period from 2007 to 2015.

Automated semantic methods of measurements of positive or negative news were applied for the analysis of the macroeconomic news. The semantic technique is related to the computational linguistic analysis of the public news to count the number of the optimistic and pessimistic macroeconomic articles, which affects the investor's sentiments in the financial market or their impact on the equity market in general. We calculate the number of optimistic and pessimistic articles using semantic technique described by Remorov [21]. The next graph plots the number of the positive and negative news for 5-min interval (in 12/02/2014) from Bloomberg news archive, Figure 1.

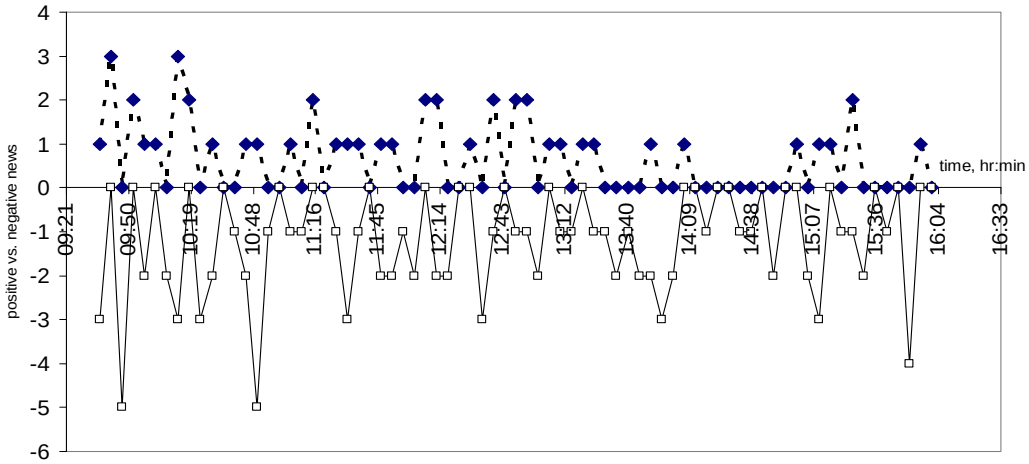


Figure 1. Observation of the number of optimistic and pessimistic macroeconomic news, Bloomberg daily news in 12/02/2014.

News source: Bloomberg News Archive.

As can been seen from Figure 1, the dynamics of the issued events of macroeconomic news during the working day exhibits a random process and close to the uniform distribution. The second graph shows the

time-series of the ratio of the numbers of the negative to positive news (pessimistic rate, PR) to quantify the investor's sentiments for period from 2007 to 2015 years, Figure 2. The PR ratio values differentiate the period of stable market and shocking market conditions in 2007-2008, moreover, the density of negative news reaches maximum during the shocking market conditions. The detailed analysis of the PR values vs. the market indices (VIX, S&P-TSX indices) was reported in [21].

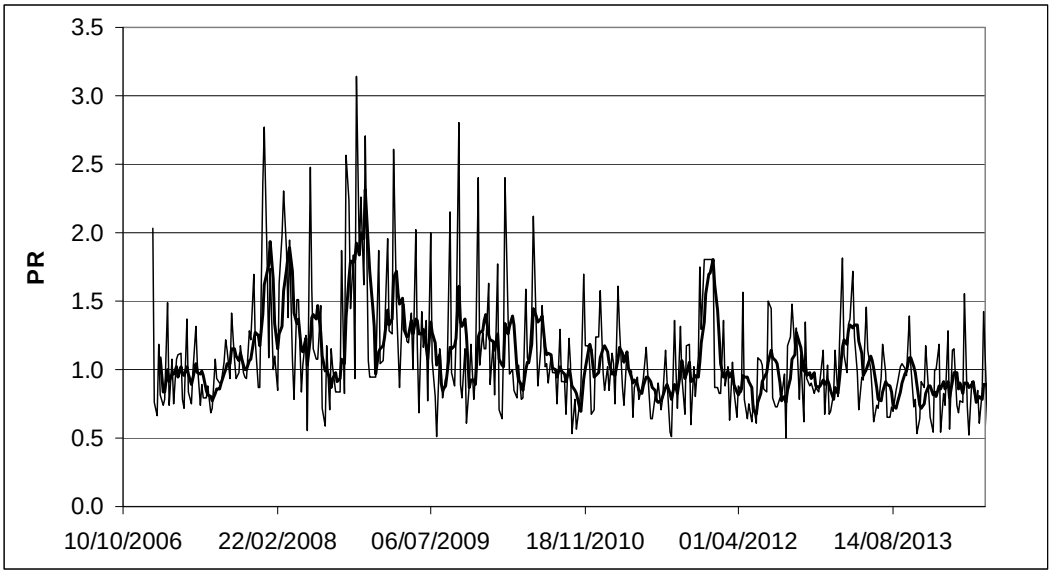


Figure 2. The ratio of issued pessimistic to optimistic news for period from 2007 to 2015 years.

News source: Reuters News Archive.

As a first step of the analysis of the interaction between the information flow and stock price change, we measured the correlation between pessimistic ratios and daily stock price return at the day of the issued news articles. The dependence on the stock price return (S&P500) on number of the positive/negative news is presented in Figure 3. As expected, the daily stock price returns exhibit the negative correlation with the pessimistic rates.

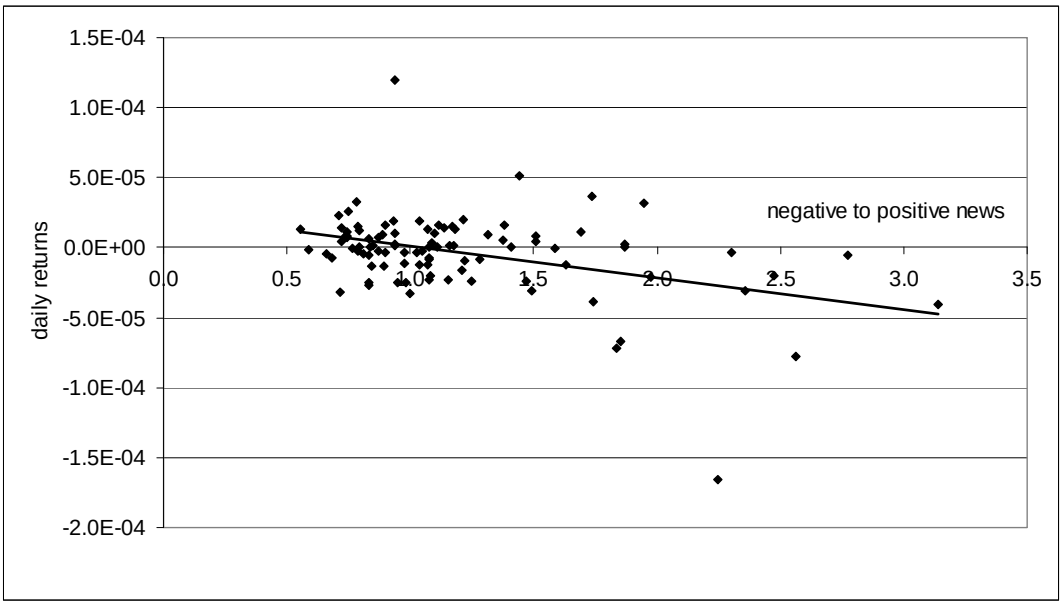


Figure 3. The pessimistic rates vs. daily index returns, SP500, from January 2007 to November 2008.

Source: Yahoo Finance, Reuters News Archive.

Case example of the dependence of the daily stock price return (Google Inc.) on the difference of optimistic and pessimistic news articles is presented in Figure 4. The correlation of the daily return and number of positive/negative news was calculated for period 2010-2012 filtering the large stock price changes (> 2%). The correlation was measured for different days of the issued articles. The results of the calculation of correlation were summarized in Figure 4. As expected, the correlation of the deference of positive and negative news with daily return of Google Inc. reaches 35% and is statistically significant at the day of the issue. The next peak is observed in 5-8 days after news issued. It is also interesting to observe the peak of the correlation of the stock price changes before news issued up to 6 days. The change of the stock price prior to issued news may be related to the trading strategies on the rumors and inside trading information. This is an important result because some event time of issued public news is not precise and gives a wrong conclusion about non-dependence or unpredictable time-series of the stock price.

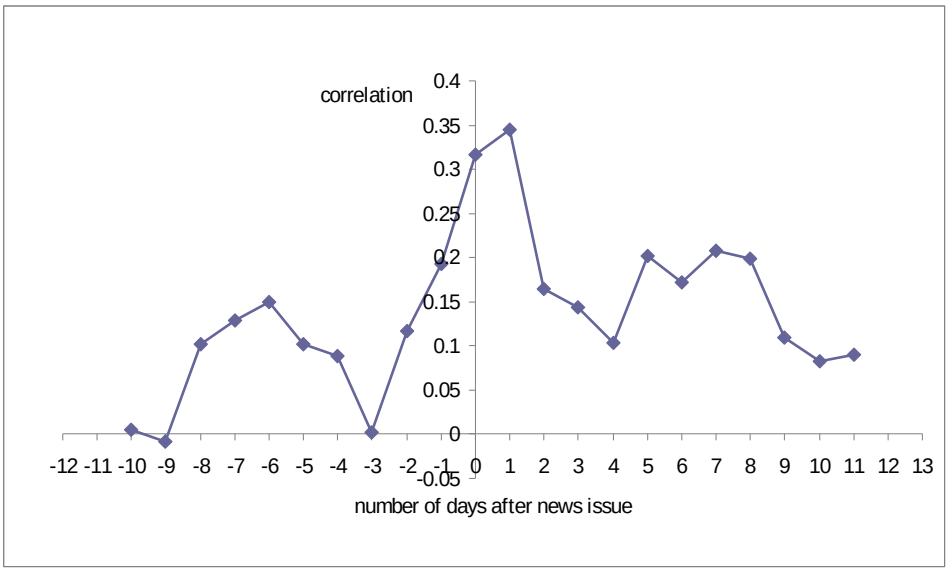


Figure 4. The correlation before and after the day of the issued articles.

The present results and literature review showed that the time-scale of the stock price changes after the news events varies in the large range from milliseconds from the booking order information to several days from macroeconomic news, and, moreover, characteristic time of the stock price change depends on the type of the information. We may conclude that the stochastic motion of the stock price is caused by competitive processes related to the negative or positive information signals with specific probabilistic rates. Thus the supply function of shares, J, is proportional to the probabilistic rate. Therefore,

$$J = kA_0. \tag{2}$$

where k is the probabilistic rate or ***impact rate,*** A_0 is not-actively traded outstanding shares in inventory.

The pessimistic information signals are associated with the supply function of the shares. Taking into account different news signals, total supply function is expressed as:

$$J^- = \sum_{i=1}^{N^-} k_i^- A_0 \tag{3}$$

where N^- is the number of bad news. We can also describe the same functionality for positive news, which can affect trading cash:

$$J^+ = \sum_{i=1}^{N^+} k_i^+ C_0 \tag{4}$$

N^+ is number of good news, k_i^+ is the ***impact rate*** of positive news, C_0 is cash in inventory.

Remorov [21, 22] showed that the number of negative news exceeds the number of positive news during financial crisis, therefore the impact rates values, k_i^-, is sustainable, and impact rate k_i^+ is close to zero:

$$k_i^+ \approx 0. \tag{5}$$

3. Model

The current model is a part of the kinetic approach for the description of the stock price dynamics presented in [20, 22]. The present model is applicable for both equilibrium and non-equilibrium market conditions.

Let us consider exchange trade process, for which the stock price changes are defined by the market agents willing to buy or sell shares, that can lead to the changes of the price rates by increasing or decreasing of the shares demand (the trade process may be viewed as the exchange of the shares and currency are in the local market). The trade exchange is affected by the macroeconomic factors through behavioral process of investor activity or their sentiments. We assume that any stock price rate changes are affected by information signals, such as macro/micro-economic news, company specific information or inside trading information. Thus, the model accepts the deterministic behavior of the stock price motion.

By analogy with microstructure model (see, for example, the review of Madhavan [23], Flood [24], Brennan and Subrahmanyam [25], we assume that the stock price is driven by the interaction between market-makers that leads to the equilibrium between demand and supply quantity. Two groups of shares are considered in the stock shares dynamics: outstanding shares actively traded by market-makers and not-actively traded outstanding shares in inventory or in long-term investment portfolios. The exchange process between two groups of outstanding shares is driven by investor's activity based on the rational and/or irrational behavior. In contrast to the microstructure model and the Zeeman's implementation of the catastrophe theory [26], the number of the outstanding shares is assumed as a model variable in the current model rather than the stock price return variable. The proposed variable allows us to apply the kinetic approach using differential equations for the description of the stock price formation. The application of differential equations for description of the dynamic system is well-known in the diffusion gas-phase kinetics (see, for example, Fick's first law, Adolf Fick (1855) [27]).

The exchange between buyers and sellers is driven by different views for the valuation of the shares, with the buyers viewing the shares as undervalued, and the sellers viewing them as overvalued. The cash-shares exchange can be described as cash-share cycle through three main cash-shares flows: the share supply flow for trading $(J_{1,i})$, exchange flow $(J_{2,i})$, cash supply flow for trading or demand flow $(J_{3,i})$. We consider two types of outstanding shares: actively traded outstanding shares or shares for short-term trading and non-actively traded outstanding shares [20, 22]. The schematic diagram of the cash-shares exchange is presented in Figure 5. Obviously, very small portion of outstanding shares are traded in the market. Therefore, it is suitable to consider local and global markets, for which any changes of stock price is related to the small changes of the investor's volume of cash and shares in the local market.

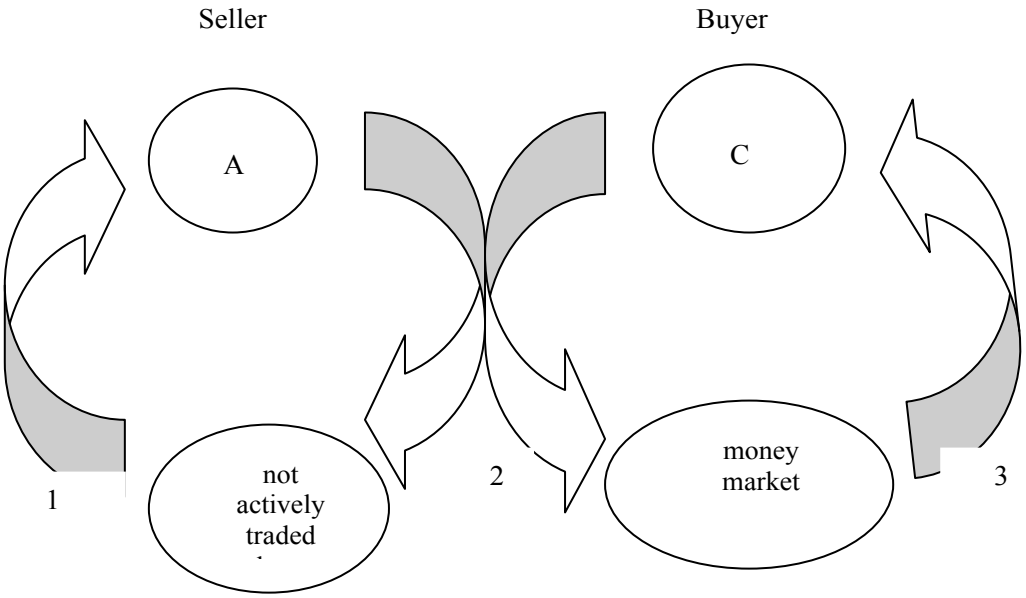


Figure 5. Cash-share exchange scheme.

The stock depends on the shares and cash traded in the local market as:

$$P = \frac{C_0 + C(t)}{A_0 + A(t)} \tag{6}$$

where $C_0, C(t)$ and $A_0, A(t)$ are cash and shares in the global and local market, respectively A_0 is considered as are not-traded shares. Obviously,

$$A(t) << A_0 \tag{7}$$

Analogously,

$$C(t) << C_0, \tag{8}$$

and

$$A_0 \approx const, \tag{10}$$

$$C_0 \approx const. \tag{11}$$

Here we postulate that the stock price is formed in a quasi-equilibrium process and the price is defined through the trade exchange in the local market, i.e. model assumes that the information about the stock price is instantaneously distributed among the agents in the local market.

We assume that the buyer intends to spend C in cash on the shares of a particular stock, and values the undervalued stock at P. According to the kinetic scheme:

$$\frac{dA}{dt} = J_1 - J_2 \tag{12}$$

$$\frac{dC}{dt} = J_3 - J_2^*. \tag{13}$$

Since both Equations (12) and (13) are expressed in different units, the exchange terms J_2 and J_2^* differ by different dimensionalities. From cash-share balance and assuming the competitive market with no-brokers fees and restrictions, the cash-share exchange terms, J_2 and J_2^*, are expressed:

$$P = \frac{J_2^*}{J_2}, \tag{14}$$

because of the coherence of two terms J_2 and J_2^*.

J_1 and J_3 are proportional to the probability of the impact of the specific information signals on investor opinions to sell or to buy shares, respectively:

$$J_1 = \sum_{i=1}^{N^-} k_i^- A_0 \tag{15}$$

$$J_3 = \sum_{i=1}^{N^+} k_i^+ C_0 \tag{16}$$

where k_i^- and k_i^+ are the impact rates, which are associated with the probability of the impact of the specific information signals on investor opinions to sell or to buy shares, respectively. Assuming uncorrelated random variables of the bad and good news, from (6) using (7, 8, 12, 13), the price differential:

$$dP \approx \frac{C_0}{A_0}\left(\frac{dC}{C_0} - \frac{dA}{A_0}\right) = P_0\left(\frac{dC}{C_0} - \frac{dA}{A_0}\right) \tag{17}$$

or

$$\frac{dP}{P_0 dt} \approx \left(\frac{J_1}{C_0} - J_2\frac{P}{C_0} - \frac{J_3}{A_0} + J_2\frac{1}{A_0}\right) \approx \left(\frac{J_1}{C_0} - \frac{J_3}{A_0}\right). \tag{18}$$

Coherence of two terms J_2 and J gives the most important conclusion in the trade market: stock price is indifferent to the trading volume, but the trading volume depends on the stock price.

Using Equations (15, 16)

$$\frac{dP}{P_0 dt} = \sum_{i=1}^{N^+} k_i^+ - \sum_{i=1}^{N^-} k_i^- . \tag{19}$$

The observed return is for period $[t_0, t]$:

$$\frac{\Delta P}{P} = \int_{t_0}^{t}\sum_{i=1}^{N^+} k_i^+ dt - \int_{t_0}^{t}\sum_{i=1}^{N^-} k_i^- dt. \tag{20}$$

As shown by many research groups, the stock price return exhibits the time-series functionality through autocorrelation and mean reversion. The probability of the impact of news can be reasonably approximated to the exponential time-dependence:

$$k_i = \begin{cases} a_i \exp(-\lambda_i t), t_i > t_0 \\ 0, t_i \le t_0 \end{cases} \tag{21}$$

where λ_i is exponential factor, a_i is the pre-exponential factor.

Equation (20) describes the stock price changes with known numbers of positive/negative news and their impact rates i.e. the number of positive/negative news and their impact rates are deterministic. We assume that the parameters k^+ and k^- are not correlated. The model requires the calibrations of the impact rates and measurements of all information signals including private and inside trading information, i.e. the solution

may become an irresolvable problem. However, the proposed kinetic scheme gives interesting conclusion that for the competitive market, the trading volume doesn't effect on the stock price return. This effect is explicitly observed for the currency exchange market, for which a large daily currency trading volume almost does not influence the exchange rates.

4. Results and Discussion

Approximation to GBM model

Let us consider some simplifications of the present model. Let us consider the market with a very fast response to the new information, i.e. with the EMH assumption:

$$\lambda_i \to \infty. \tag{22}$$

Averaging with the uniform distribution of the news events for interval from [0, T] and using Formulas (21, 22) with the equal exponential and pre-exponential factors, then the stock price return is proportional to the difference of the number of positive and negative news:

$$\frac{\Delta P}{P} \sim N^+ - N^-. \tag{23}$$

Thus, Equation (23) shows that the difference of all positive and negative news generates the stock price return. Obviously, by the central limit theorem, the large number of randomly issued positive and negative news, the pattern of the stock price return will be approximated to the normal distribution. Thus, stock price may be approximated to the GBM equation with zero drift with the condition of Equation (22).

Sharp price decline, market crash, panic effect

In this section, the model of the sharp price decline was briefly described and was previously reported by Remorov (2014 c).

The negative information flows are observed during the economic recession. Therefore,

$$J_1 >> J_2 \tag{24}$$

$$\frac{dC}{dt} \approx 0. \tag{25}$$

The system of differential equation is modified:

$$\frac{dA}{dt} \approx J_1 \tag{26}$$

$$C \approx const \tag{27}$$

If $k_i^- \approx const$ during economic recession, then

$$\frac{1}{P(t)} - \frac{1}{P(t_0)} = \frac{k_i}{C}(t - t_0). \tag{28}$$

For the *fist process* during the macroeconomic crisis, Equation (28), a selling-off decision of the investors is driven by the pessimistic investor sentiments. In this case, the daily stock price is inversely proportional to the trading period of the stock price decline.

The negative information from selling of shares can affect the investor's decision of share selling, since the new information of the stock price decline may cause the next initiation of the new share selling. Therefore, the information-impact process from the price decay is the cycle chain process, see [22]. The second process exhibits the ”snowball” effect of the growth of the selling shares, the share growth rate will be proportional to the selling shares:

$$J_1 = k_i + k_c A_s \tag{29}$$

where k_c is the probabilistic parameter, which describes the chain process. Using $C \approx const,$ the solution of Equation (12, 13) is:

$$\frac{1}{P(t)} = \left(\frac{k_i}{Ck_c} + \frac{1}{P(t_0)} \right) \exp(k_c(t - t_0)) - \frac{k_i}{Ck_c}. \tag{30}$$

For *the second process*, Equation (30), the market crash or sharp price decline is explained by the herd behavior process, for which new information of the stock price decline may cause the next initiation of new selling-off of the shares. The proposed model is confirmed by the observations of the stock price decline of Enron, Citigroup, AIG and so on [22].

Stock Price Returns on Information Signals or Impact Rates

The impact rates can be estimated using a fitting procedure of the time-dependence of the stock price:

$$k = \frac{dP}{Pdt}. \tag{31}$$

As shown in the literature review, the impact rates depend on the type of news and exponential factors may vary from milliseconds^{-1} to days^{-1}. The numerical solutions of the Equations (12, 13) require the numerical fitting approaches with different impact rates.

The present model assumes that the impact rates have exponential dependence on time, which is reasonable assumption for the response time events to the information signals. The exponential dependence may be also explained by the limit amount of shares in the inventory. For example, the change of shares, which are supplied for selling, can be expressed by the kinetic equation (ignoring the exchange trade process):

$$\frac{dA(t)}{dt} = k^*(A_{inventory} - A(t)) \tag{32}$$

where k^* is the constant rate related to the response probability to the information in the market. Solving Equation (32):

$$A(t) = A_{inventory}(1 - e^{-k^* t}). \tag{33}$$

The above the time-dependence of values of actively traded shares is similar to the cumulative distribution function of the exponential distribution. Thus, we may assume that the exponential factor is related to the specific information signals and the pre-exponential factor is the characteristics of the amount of cash and shares in the inventory.

Uncertainty in the stock price forecast

Our observations showed that the change of the stock price may by caused by the trading strategies on the rumors and inside trading information, i.e. stock price may be changed prior to the issued articles, see Figure 4. Therefore, the impact of the issued articles is diluted by the "rumors" effect and the predicted stock price return will be always less than the actual stock price return:

$$\left|\frac{\Delta P}{P}\right| > \left|\frac{\Delta P_{predicted}}{P_{predicted}}\right| \tag{34}$$

or

$$|r| > |r_{predicted}|. \tag{35}$$

Trading exchange, J_2

Trading exchange terms J_2 and J_2^* are key concepts in the kinetic scheme and provide shares and cash cycles, respectively. The relationship between J_2 and J_2^* defines the formation of the price through trading exchange, see Equations (12, 13). The trading exchange flow J_2 is the trading volume of shares in units of shares per unit of time and the trading exchange flow J_2^* is the trading volume of cash in units of cash per unit of time. Trading exchange term J_2 in kinetic scheme, Figure 5, was investigated by Remorov [22]. Briefly, according to the model, the exchange between buyers and sellers is driven by different views for the valuation of the shares, with the buyers viewing the shares as undervalued, and the sellers viewing them as overvalued. We assume that the buyer intends to spend C_a in cash on the shares of a particular stock, and values the undervalued stock at P_b. Then we can define his *hypothetical* number of shares as the ratio of C_a / P_b. The number of shares A_s is known for a seller *s*. The proposed assumption of the hypothetical buyer's shares allows us to apply the interaction between the buyers and shares in the same dimensionality.

The trading exchange may occur for the specific time interval with the probabilistic function R, which will be called the exchange rate. The rate of interaction between two groups of agents will be proportional to the shares A_b, A_s, and the exchange rate, which is defined by the probabilistic function R_i.

The rate of interaction for shares at time *t* can be expressed as:

$$J_i = R_i A_{b,i} A_{s,i}, \tag{36}$$

where j_i is the number of elementary exchanged shares. The total exchange volume is

$$J = \sum_{i=1}^{N} R_i A_{b,i} A_{s,i} \tag{37}$$

where *N* is the number of sets of buyers and sellers, J is the total number of trades for a specific time interval, i.e. the trading volume. According to the reflexivity approach developed by Soros (1987), participant understanding of the market is imperfect with different expectation views of the stock price valuation. Therefore, the exchange rates, R_i, are the

stochastic functions, which describe the expectation view of the market participants. If the stock market is in the equilibrium, then Equation (37) describes the stochastic process of the trading volume.

Panic market conditions are characterized by the properties of the self-organized market, for which almost all agents have similar expectations of the stock price decline (Soros (1987) [28]). Applications of the various hedging strategies to survive the money paper wealth are very limited because of the limited number of investors, which want to buy the shares with low credit quality or set of seller of the shares significantly exceeds the portion of the market participants, which want to buy. In this case, the expectation prices of the buyers are almost the same for different groups of agents; moreover, the exchange rates R_i are assumed almost the same:

$$R_1 \approx R_2 \approx ... \approx R_N. \tag{38}$$

It is necessary to take into account that for the panic market conditions, the expectation price of the buyers is defined by the current stock price of the market. Therefore, the equation of the total trading volume is simplified:

$$J = R\sum_{i=1}^{N} A_{b,i} A_{s,i}. \tag{39}$$

We can conclude that the cash balance exists between sellers and buyers during trading. Therefore, using Equations (38) and (39) and cash balance, i.e. the sellers convert existing shares A_{si} to the cash with price P, we have:

$$J = R\sum_{i=1}^{N} \frac{C_i}{P} A_{s,i} = R\sum_{i=1}^{N} \frac{C_i}{P}\frac{C_i}{P} = \frac{R}{P^2}\sum_{i=1}^{N} C_i^2. \tag{40}$$

Since the money market is much larger than the market of the given shares, the impact of the depreciation of the shares cannot significantly influence the money market. Therefore, the trading volume is almost independent from the money market. Thus, Equation (40) can be simplified:

$$J = R_c \frac{1}{P^2}, \tag{41}$$

where

$$R_c = \sum_{i=1}^{N} C_i^2 \approx const. \tag{42}$$

Thus, we can see that two main regimes of stock price movement may exist: stochastic dynamics, Equation (37), and price-driven dynamics, Equation (42). Obviously, Equation (42) describes the ideal case, when all agents follow the same law of market panic condition. If the process doesn't follow the condition (38), the trading volume follows the random-walk movement.

Simulation of the Stock Price

The dynamics of non-equilibrium process can be studied by the simulation of the stock price formation by solving the differential equations with known probabilistic rates using the proposed kinetic scheme as shown in Figure 5. To simulate the elementary trading process for the non-equilibrium market conditions, we suppose the stochastic process of response time with exponential distribution. The initial cash and share volume for trading are selected in dimensionless units with initial conditions:

$$C_0 = 1 \tag{43}$$

$$A_0 = 1 \tag{44}$$

$$C(t) = 0 \tag{45}$$

$$A(t) = 0. \tag{46}$$

The probability rates $k_{1,3}$ are defined from the simulation of response time as stochastic process according to the exponential distribution with the known exponential factors λ. For simplicity, we consider single news event with equal exponential factors of the impact rates, but different pre-exponential factors. For non-equilibrium market conditions, we consider the case, when the impact rates of positive news exceed the impact rates of negative news. The simulation of the daily trading process are carried out with 10000 time steps and for different exponential factors from 1 to 0.01 with the given initial conditions, see Equations (43-46). Ideally, the simulation of trading process should include the broker fees and taxes, but we assumed that the elementary trading exchange occurs irreversibly and instantaneously without interface resistance between buyers and sellers through the market system.

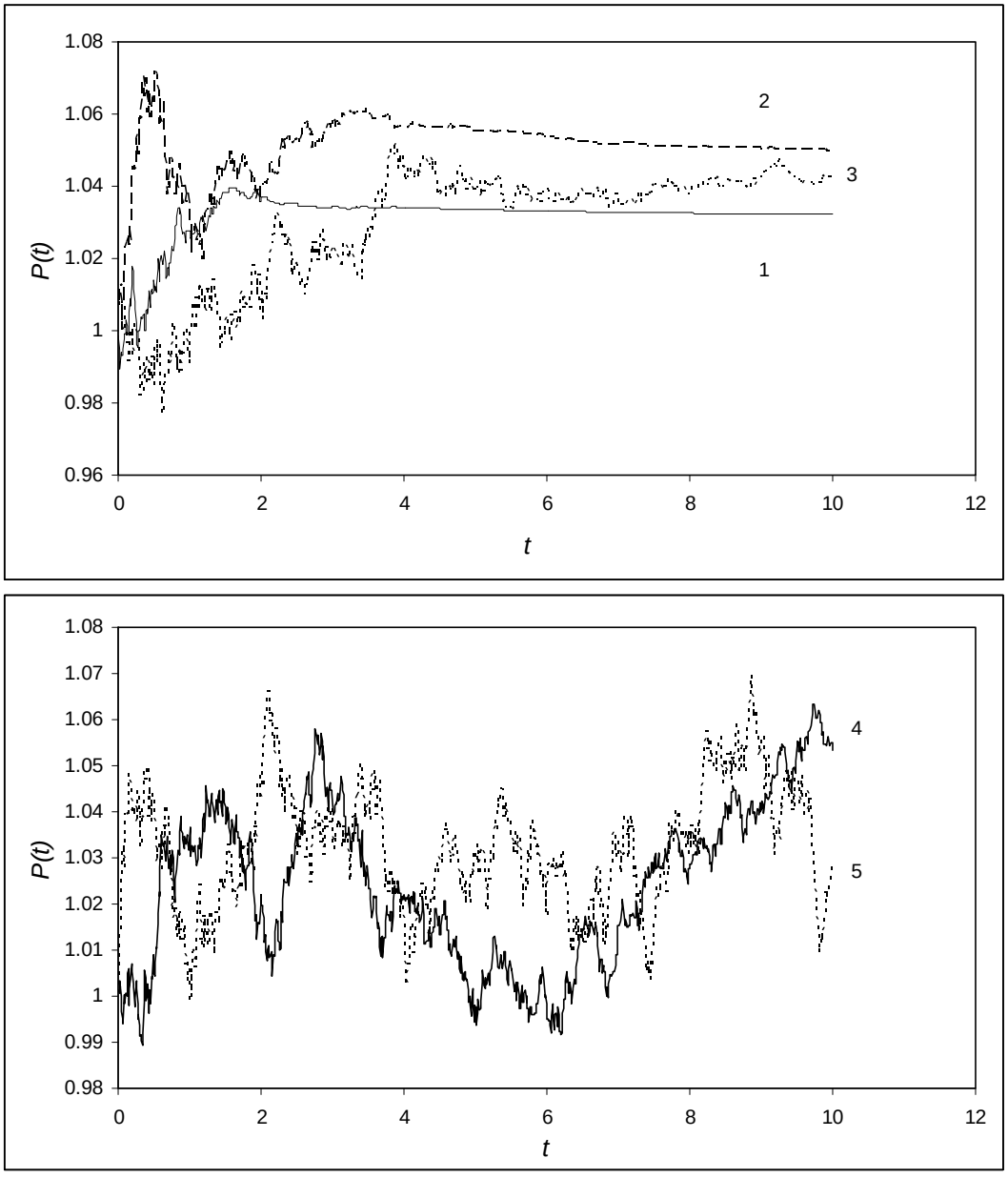


Figure 6. The example of the numerical simulation of the stock price using differential equations (12, 13) for different exponential factors $\lambda = 1(1)$, $\lambda = 0.5(2)$, $\lambda = 0.2(3)$, $\lambda = 0.1(4)$, $\lambda = 0.01(5)$. Model parameters: $a^{+} = 1.1$, $a^{-} = 1$, $k_2 = 0.01$.

Figure 6 summarizes the results of the simulation for the different exponential factors from 1 to 0.01. As we expected, the stock price exhibits the random-walk process in the case of the low values of the exponential

factors. The non-equilibrium and equilibrium market conditions is clearly observed for the simulated stock price with the large values of the exponential factors, in contrast to the random-walk process with the low exponential factors.

5. Conclusion

This paper studies the non-equilibrium stock price dynamics with application of the kinetic approach with focus on the impact of the public information on the behavioral processes. The application of the presented model is very broad, in particular, the model can be used for the description of the time-series dependence of the foreign exchange rates.

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THE CHAOTIC PUBLIC DEBT GROWTH MODEL: GREECE

Vesna D. JABLANOVIC*

Abstract. *Chaos theory is used to prove that chaotic fluctuations can indeed arise in completely deterministic models. Chaotic systems exhibit a sensitive dependence on initial conditions: seemingly insignificant changes in the initial conditions produce large differences in outcomes.*
The basic aim of this analysis is to provide a relatively simple chaotic public debt growth model that is capable of generating stable equilibria, cycles, or chaos. It is important to analyze the stability of the public debt growth in Greece in the period 2000-2014. This paper confirms stable growth of the public debt in Greece in the observed period.

Keywords: *Public debt, Growth, Chaos O4, H62.*

1. Introduction

The global financial crisis developed with remarkable speed starting in the late summer of 2008. This crisis has damaged a large part of the world's financial system. A typical financial crisis is described by declines in asset prices. Government budget deficit raises real interest rates. When the government spends more money than it spends, then the government runs a budget deficit and public saving becomes a negative number. Further, the higher interest rate reduces net foreign investment (net capital outflow). Reduced net foreign investment (net capital outflow), in turn, reduces the supply of domestic currency in the market for foreign-currency exchange, which causes the real exchange rate of domestic currency to appreciate.

In an open economy, government budget deficit raises real interest rates, crowds out domestic investment, decreases net capital outflow, decreases the level of asset prices, and causes the domestic currency to appreciate. However this appreciation makes domestic goods and services more expensive compared to foreign goods and services. In this case, exports fall, and imports rise. A decrease in aggregate demand causes output and prices to fall. The recession may further increase budget deficit and public debt.

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The European debt crisis is a debt crisis that has taken place in several eurozone member states since the end of 2009. The European debt crisis was characterized by an environment of overly high government structural deficits and accelerating debt levels. The states faced a strong rise of interest rate spreads for government bonds. The Greek government-debt crisis is generated by strong increase in government debt levels along with continued existence of high structural deficits.

Deterministic chaos refers to irregular or chaotic motion that is generated by nonlinear systems evolving according to dynamical laws that uniquely determine the state of the system at all times from a knowledge of the system's previous history. Chaos embodies three important principles: (*i*) extreme sensitivity to initial conditions; (*ii*) cause and effect are not proportional; and (*iii*) nonlinearity

The basic aim of this analysis is to provide a relatively simple chaotic public debt growth model that is capable of generating stable equilibria, cycles, or chaos. It is important to analyze the stability of the public debt growth in Greece in the period 2000-2014. This paper confirms stable growth of the public debt in Greece in the observed period.

2. Methodology

Chaos theory is used to prove that erratic and chaotic fluctuations can indeed arise in completely deterministic models. Chaos theory reveals structure in aperiodic, dynamic systems. The number of nonlinear business cycle models use chaos theory to explain complex motion of the economy. Chaotic systems exhibit a sensitive dependence on initial conditions: seemingly insignificant changes in the initial conditions produce large differences in outcomes. This is very different from stable dynamic systems in which a small change in one variable produces a small and easily quantifiable systematic change.

Chaos theory started with Lorenz's [1963] discovery of complex dynamics arising from three nonlinear differential equations leading to turbulence in the weather system. Li and Yorke [1975] discovered that the simple logistic curve can exhibit very complex behavior. Further, May [1976] described chaos in population biology. Chaos theory has been applied in economics by Benhabib and Day [1981, 1982], Day [1982, 1983], Baumol W. & Benhabib, J. [1989], Grandmont [1985], Goodwin [1990], Medio [1993], Lorenz [1993], Jablanovic [2010, 2012a, 2012b], Puu, T. [2003], Zhang W. B. [2006], among many others.

3. The model

The chaotic public debt growth model can be described by the following equations:

$$S_t = I_t + NCO_t + rB_{t-1} \tag{1}$$

$$S_t = sY_t \tag{2}$$

$$k_m = \frac{\Delta K}{\Delta Y} \tag{3}$$

$$NCO_t = nY_t \tag{4}$$

$$I_t = K_{t+1} \tag{5}$$

$$B_{t-1} = dY_t \tag{6}$$

$$Y_t = K_t^{1/2}. \tag{7}$$

Where: S – national saving; Y – the real gross domestic product; NCO – net capital outflow (net foreign investment); I – investment; B – public debt; n – net capital outflow as a percent of the real gross domestic product; d – public debt as a percent of the real gross domestic product; K – capital; K_m – the marginal capital coefficient; ΔK – the increment in capital; ΔY – the increase in output (GDP); r – real interest rate; s – saving rate.

By substitution one derives:

$$B_t = \left[\frac{(s - n - r\ d + k_m)}{k_m}\right] B_{t-1} - \left(\frac{1}{d\ k_m}\right) B_{t-1}^{\ 2}. \tag{8}$$

Further, it is assumed that the current value of the public debt is restricted by its maximal value in its time series. This premise requires a modification of the growth law. Now, the public debt growth rate depends on the current size of the public debt, B, relative to its maximal size in its time series B^m. We introduce b as $b = B / B^m$. Thus b range between 0 and 1. Again we index b by t, *i.e.*, write b_t to refer to the size at time steps $t = 0,1,2,3,...$ Now growth rate of the public debt is measured as:

$$b_t = \left[\frac{(s - n - r\ d + k_m)}{k_m}\right] b_{t-1} - \left(\frac{1}{d\ k_m}\right) b_{t-1}^{\ 2}. \tag{9}$$

This model given by equation (9) is called the logistic model. For most choices of s, n, r, d, and K_m there is no explicit solution for (9). This

is at the heart of the presence of chaos in deterministic feedback processes. Lorenz (1963) discovered this effect – the lack of predictability in deterministic systems. Sensitive dependence on initial conditions is one of the central ingredients of what is called deterministic chaos.

This kind of difference equation (9) can lead to very interesting dynamic behavior, such as cycles that repeat themselves every two or more periods, and even chaos, in which there is no apparent regularity in the behavior of b_t. This difference equation (9) will possess a chaotic region. Two properties of the chaotic solution are important: firstly, given a starting point b_0 the solution is highly sensitive to variations of the parameters *s*, *n*, *r*, *d*, and K_m; secondly, given the parameters *s*, *n*, *r*, *d*, and K_m, the solution is highly sensitive to variations of the initial point b_0. In both cases the two solutions are for the first few periods rather close to each other, but later on they behave in a chaotic manner.

4. The logistic equation

The logistic map is often cited as an example of how complex, chaotic behavior can arise from very simple non-linear dynamical equations. The logistic model was originally introduced as a demographic model by Pierre François Verhulst, a Belgian mathematician interested in the modeling of human populations. He applied his logistic equation for population growth to demographic studies. The model was created to produce solutions for a single population that grows from a small initial number of individuals to a limited population with an upper bound implicitly set by factors such as food supply, living space or pollution (the effect of a "carrying capacity" that would limit growth). His formula is called the "logistic model" or the Verhulst model.

It is possible to show that iteration process for the logistic equation

$$z_t = \pi\, z_{t-1}(1 - z_{t-1}), \quad \pi \in [0,4], \quad z_t \in [0,1] \tag{10}$$

is equivalent to the iteration of growth model (9) when we use the identification

$$z_t = \frac{1}{d\ (s - n - r\ d + k_m)}\, b_t \tag{11}$$

and

$$\pi = \left[\frac{(s - n - r\ d + k_m)}{k_m} \right]. \tag{12}$$

Using (9) and (11) we obtain

$$z_t = \frac{1}{d\ (s-n-r\ d+k_m)}\, b_t =$$

$$= \left[\frac{1}{d\ (s-n-rd+k_m)}\right]\left\{\left[\frac{(s-n-r\ d+k_m)}{k_m}\right] b_{t-1} - \left(\frac{1}{d\ k_m}\right) b_{t-1}{}^2\right\}$$

$$= \left\{\left(\frac{1}{dk_m}\right) b_{t-1} - \left(\frac{1}{d^2 k_m (s-n-rd+k_m)}\right) b_{t-1}{}^2\right\}.$$

On the other hand, using (10), (11) and (12) we obtain

$$z_t = \pi\ z_{t-1}(1-z_{t-1}) =$$

$$= \left[\frac{(s-n-r\ d+k_m)}{k_m}\right]\left[\frac{1}{d\ (s-n-rd+k_m)}\right] b_{t-1}\left\{1-\left[\frac{1}{d\ (s-n-rd+k_m)}\right] b_{t-1}\right\}$$

$$= \left\{\left(\frac{1}{dk_m}\right) b_{t-1} - \left(\frac{1}{d^2\ k_m\ (s-n-rd+k_m)}\right) b_{t-1}{}^2\right\}.$$

Thus we have that iterating (10) is really the same as iterating $z_{t+1} = \pi\ z_t(1-z_t)$ using (11) and (12). It is important because the dynamic properties of the logistic equation (10) have been widely analyzed (Li & Yorke [1975], May [1976]).

It is obtained that:

- For parameter values $0 < \pi < 1$ all solutions will converge to $z = 0$;
- (ii) For $1 < \pi < 3.57$ there exist fixed points the number of which depends on π;
- (iii) For $1 < \pi < 2$ all solutions monotonically increase to $z = (\pi - 1)/\pi$;
- (iv) For $2 < \pi < 3$ fluctuations will converge to $z = (\pi - 1)/\pi$;
- (v) For $3 < \pi < 4$ all solutions will continuously fluctuate;
- (vi) For $3{,}57 < \pi < 4$ the solution become "chaotic" which means that there exist totally aperiodic solutions or periodic solutions with a very large, complicated period. This means that the path of z_t fluctuates in an apparently random fashion over time, not settling down into any regular pattern whatsoever.

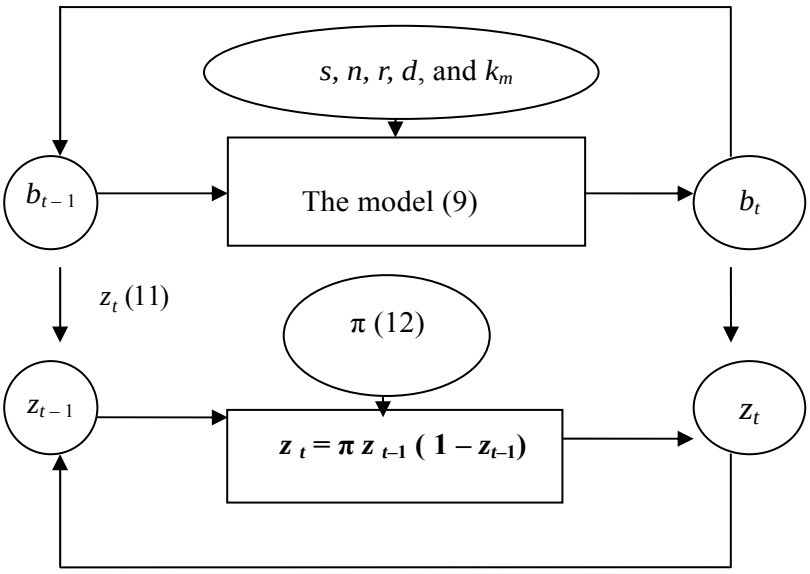


Figure 1. Two quadratic iterations running in phase are tightly coupled by the transformations indicated.

5. Empirical Evidence

The main aim of this paper is to analyze the public debt growth stability in the period 2000-2014, in Greece, by using the presented non-linear, chaotic public debt growth model (13):

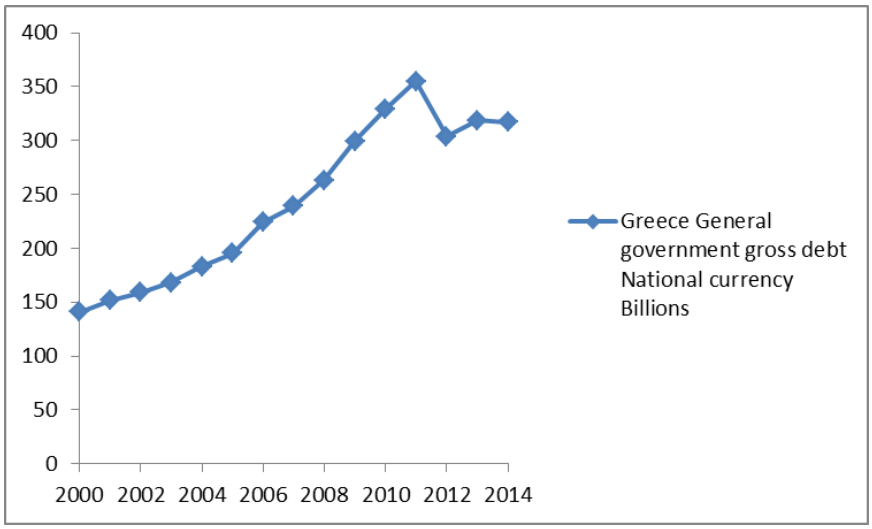


Figure 2. General government gross debt (billions Euros): Greece 2000-2014 (www.imf.org)

$$b_t = \pi\, b_{t-1} - \theta\ b_{t-1^2} \qquad (13)$$

where:

b – the public debt,

$$\pi = \left[\frac{(s - n - r\ d + k_m)}{k_m} \right],$$

$$\theta = \left(\frac{1}{dk_m} \right).$$

Firstly, data on the public debt are transformed (www.imf.org) from 0 to 1, according to our supposition that actual value of the public debt, B, is restricted by its highest value in the time-series, B_m. Further, we obtain time-series of $b = B / B^m$.

Table 1.

The estimated model (13): Greece, 2000-2014 (Variance explained: 93.194%)

	π θ
Estimate	1.25214 .268663
Std.Err.	.9171 .114257
***t*(12)**	13.65368 2.351395
***p*-level**	0.0000 0.036620

(www.imf.org)

6. Conclusion

This paper creates the simple chaotic public debt growth model. The model (9) has to rely on specified parameters s, n, r, d, and k_m, and initial value of the public debt, b_0. This difference equation (9) will possess a chaotic region. Two properties of the chaotic solution are important: firstly, given a starting point b_0 the solution is highly sensitive to variations of the parameters s, n, r, d, and k_m; secondly, given the parameters s, n, r, d, and k_m, the solution is highly sensitive to variations of the initial point b_0. In both cases the two solutions are for the first few periods rather close to each other, but later on they behave in a chaotic manner. A key hypothesis of this work is based on the idea that the coefficient $\pi = (s - n - r\ d + k_m) / k_m$, where: r – real interest rate, s – saving rate,

n – net capital outflow as a percent of the real gross domestic product, d – public debt as a percent of the real gross domestic product, k_m – the marginal capital coefficient.

The estimated value of the coefficient π is greater than 1. This result confirms stable public debt growth in Greece in the period 2000-2014. In accordance with the obtained results, fiscal policy reforms are recommended.

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COMPARATIVE ANALYSIS IN STUDY OF CLASSICAL DIFFERENTIAL MAXWELL SYSTEM FOR THE SLOW-GUIDED STRUCTURES

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Abstract. *Two analytical methods in electrodynamics are proposed here basing on the mathematical models in terms of the finite dimensional systems of PDEs (partial differential equations). Both algorithms reduce the original matrix problem to the general wave equation regarding all unknown scalar components of electromagnetic field vector intensities. This wave PDE is solved explicitly in the unified manner irrespectively of concrete boundary value problem statement. Detailed analysis of restrictions in the framework of classical Maxwell theory is suggested as well using both aforesaid analytic techniques in the class of not generalized functions. Efficiency of those research trends is shown in the case of slow-guided structures dealing with electromagnetic wave propagation in the Cartesian coordinate system.*

Keywords and phrases: *classical Maxwell theory, electromagnetic wave propagation, general wave equation, explicit solution.*

1. Introduction

In spite of various numerical methods and subroutines in electrodynamics [1], new analytic procedures remain also required on solution of modern industrial problems dealing with electromagnetic field theory [2]. Rather often, it even happens that desire for more accuracy in approximate computation, in reality gives wrong result having nothing in common with the existing physical or engineering process [1], [2]. Moreover, sometimes the lack of appropriate exact mathematical algorithm leads to severe contingencies of the original problem statement. Thus in [3], the classical differential Maxwell equations for a homogeneous isotropic media in the Cartesian coordinate system were roughly reduced to the degenerate version with vanishing current (charges) $\vec{i} = \vec{i}(x, y, z, t)$ and

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charge density $\rho = \rho(x, y, z, t)$. Though the authors in [3] had a claim on the analytic research of electromagnetic wave propagation in the slow-guided structures, their suggested approach not only narrowed mathematical and physical formulation, but also completely spoiled expected results.

It is one of several reasons why the goal of the present paper consists in the presentation of two explicit techniques concerning diagonalization of the finite dimensional square systems of PDEs with piecewise constant coefficients and invertible terms commutative in pairs [4], [5]. Diagonalization means here reduction of the initial matrix problem to the equivalent union of scalar equations where each of them depends on the only one component of the unknown vector field function. Actually, the latter is present implicitly in the aforesaid original system of PDEs.

Returning to the above mentioned set of scalar equations, it is easy to understand that their solving is simpler in comparison with matrix form. Finally, all found solutions uniquely determine the required vector field function. Besides, mathematical modeling of engineering processes using relevant boundary value problems is better to do for scalars avoiding vectors whose study usually remains more complicated and even vague.

Closing this section, it should be noted that since the topic of given article deals with the analytical methods applicable to technical electrodynamics, in further results we are going to show as all virtues of the suggested here investigation, as all drawbacks of the ungrounded trend from [3].

2. Preliminaries

Let the classical differential Maxwell equations in the Cartesian coordinate system and for isotropic homogeneous linear media be given

$$\begin{cases} \mathbf{rot}\,\vec{H} = \partial_0 \vec{D} + \vec{i}, \\ \mathbf{rot}\,\vec{E} = -\partial_0 \vec{B}, \\ \operatorname{div}\vec{D} = \rho; \;\; \vec{D} = \varepsilon\vec{E}, \\ \operatorname{div}\vec{B} = 0; \;\; \vec{B} = \mu\vec{H}, \\ \vec{i} = \sigma\vec{E}. \end{cases} \tag{1}$$

In (1): $\vec{E}, \vec{H} = \vec{E}, \vec{H}(x, y, z, t)$ are the unknown electromagnetic field vector intensities with scalar components $E_i, H_i = E_i, H_i(x, y, z, t)$, $(i = \overline{1, 3})$; $\vec{D}, \vec{B} = \vec{D}, \vec{B}(x, y, z, t)$ describe the induction of electric and magnetic field

respectively; $\vec{i} = \vec{i}(x, y, z, t)$ and $\rho = \rho(x, y, z, t)$ determine the current (charges) and charge density; σ, $\mu = \mu_0 > 0$, $\varepsilon = \varepsilon_0 > 0$ denote specific conductivity, relative magnetic and electric permeability of the medium; $\partial_0 = \dfrac{\partial}{\partial t}$; $\operatorname{rot} F_k = \det \begin{bmatrix} \vec{i} & \vec{j} & \vec{k} \\ \partial_1 & \partial_2 & \partial_3 \\ F_{k1} & F_{k2} & F_{k3} \end{bmatrix}$, $\operatorname{div} \vec{F}_k = \sum_{i=1}^{3} \partial_i F_{ki}$ represent the fundamental field operations, where $\partial_1 = \dfrac{\partial}{\partial x}$, $\partial_2 = \dfrac{\partial}{\partial y}$, $\partial_3 = \dfrac{\partial}{\partial z}$, and $F_{ki} = F_{ki}(x, y, z, t)$ $(k = 1, 2; i = \overline{1, 3})$ are the corresponding scalar components of electromagnetic field vector intensities $\vec{F}_1, \vec{F}_2 = \vec{F}_1, \vec{F}_2(x, y, z, t)$, $\vec{F}_1, \vec{F}_2 = \vec{E}, \vec{H}$.

Diagonalization of (1) will be done later using two new analytical methods [4], [5]. The first one [4] is the operator generalization of algebraic Gauss method [6]. The second procedure [5] suggests the inverse matrix operator construction. Both of them effectively reduce (1) to the general wave PDE regarding all unknown scalar components of the electromagnetic field vector intensities.

Practically, system (1) was base in [3] investigating electromagnetic wave propagation in the slow-guided structures. Tthough results of [3] aspired to strictly analytical level of study, unfortunately, system (1) was considered in [3] only with hard constraints of $\vec{i} = 0$, $\rho = 0$ and $\sigma = \infty$. Additionally, it was assumed in [3] that time change of electromagnetic field obeyed the law $\exp(i\omega t)$, i. e. $E, H \approx \exp(i\omega t)$, where $i = \sqrt{-1}$ and ω is the vibration frequency.

Perhaps, such breaking of the original physical and mathematical statement was connected with definition of the slow-guided system [3] as the metallic one, not having either magnetics or dielectrics, or charges $\vec{i} = 0$, $\rho = 0$ inside. Perfect conductivity $\sigma = \infty$ and $E, H \approx \exp(i\omega t)$ are also assumed.

The above mentioned restrictions, including influence of ∂_0 on the electromagnetic field vector intensities, naturally take (1) to the following peculiar form

$$\begin{cases} \mathbf{rot}\, \vec{H} = \varepsilon_0 \partial_0 \vec{E} = i\varepsilon_0 \omega \vec{E}, \\ \mathbf{rot}\, \vec{E} = -\mu_0 \partial_0 \vec{H} = -i\mu_0 \omega \vec{H}, \end{cases} \Leftrightarrow \begin{cases} \mathbf{rot}\, \vec{E} + i\mu_0 \omega \vec{H} = 0, \\ -i\varepsilon_0 \omega \vec{E} + \mathbf{rot}\, \vec{H} = 0. \end{cases} \qquad (2)$$

Even such cutoff version (2) was considered without longitudinal or transverse waves in [3]. Analytical explicit solution was not also proposed [3].

Nevertheless, the aforesaid methods of [4] and [5] will be shown in the next section for (2) as well, but only when complete exact study of (1) is done.

3. Results

Returning to (1), after obvious transformations, we write this system in the equivalent way

$$\begin{cases} \mathbf{rot}\,\vec{H} = \varepsilon\partial_0\vec{E} + \sigma\vec{E}, \\ \mathbf{rot}\,\vec{E} = -\mu\partial_0\vec{H}, \\ \varepsilon\,\mathrm{div}\,\vec{E} = \rho, \\ \mu\,\mathrm{div}\,\vec{H} = 0. \end{cases} \Leftrightarrow \begin{cases} (\varepsilon\partial_0 + \sigma)\vec{E} - \mathbf{rot}\,\vec{H} = 0, \\ \mathbf{rot}\,\vec{E} + \mu\partial_0\vec{H} = 0, \\ ---------- \\ \mathrm{div}\,\vec{E} = \rho/\varepsilon, \\ \mathrm{div}\,\vec{H} = 0. \end{cases} \tag{3}$$

The next step concerns diagonalization of the first pair of equations from (3). The main aim here is obtaining of the general wave PDE regarding all scalar components of electromagnetic field vector intensities.

Since the subsystem of those two equations is homogeneous, method of inverse matrix operator construction [5] as the essential generalization of algebraic approach [6], appears improper. It is well known [6] that homogeneous algebraic square systems have the unique and only zero solution when their determinants equal zero. The last fact completely excludes inverse matrix operator construction whose existence is possible only in the case of nonzero system determinant [5]. That is why diagonalization of the first subsystem from (3) is done by the operator generalization of Gauss method [4]. Namely, application of operators $\mu\partial_0$ and **rot** to the first and the second equations of the mentioned subsystem respectively, after term-by-term addition of those both transformed equations, leads to the equivalent system regarding (3)

$$\begin{cases} (\mathbf{rot}^2 + \mu\partial_0(\varepsilon\partial_0 + \sigma))\vec{E} = 0, \\ \mathbf{rot}\,\vec{E} + \mu\partial_0\vec{H} = 0. \end{cases} \tag{4}$$

The first equation in (4) depends already on the only one electric field vector intensity $\vec{E}$.

The next action of operators $(-\mathrm{rot})$ and $(\mathrm{rot}^2 + \hat{\partial}_0^2)$ on the first and the second equations in (4) with the further term-by-term addition of those two transformed ones, again gives the equivalent system

$$\begin{cases} (\mathrm{rot}^2 + \hat{\partial}_0^2)\vec{E} = 0, \\ \mu\partial_0(\mathrm{rot}^2 + \hat{\partial}_0^2)\vec{H} = 0, \end{cases} \tag{5}$$

where

$$\hat{\partial}_0^2 = \mu\partial_0(\varepsilon\partial_0 + \sigma). \tag{6}$$

Now, the second equation in (5) is dependent on the only one magnetic field vector intensity $\vec{H}$. It is obvious that (5) represents diagonalization of (1) at the electromagnetic field vector level.

Obtaining of the general wave equation regarding all scalar components of $\vec{E}$, $\vec{H}$ demands expressing of (6) in coordinates basing on the identity of the classical field theory [7]

$$\mathbf{rot}^2 = \mathbf{grad}\,\mathrm{div} - \Delta, \text{ and } \Delta = \sum_{i=1}^{3}\partial_i^2 \text{ is the Laplace operator.} \tag{7}$$

Owing to the third and fourth equations from (3), use of (7) substantially simplifies (5) giving the following

$$\begin{cases} (\hat{\partial}_0^2 - \Delta)\vec{E} = -\dfrac{1}{\varepsilon}\mathbf{grad}\rho, \\ \mu\partial_0(\hat{\partial}_0^2 - \Delta)\vec{H} = 0. \end{cases} \tag{8}$$

The main assumption here is the specification of scalar function $\rho = \rho(x, y, z, t)$ making $\mathrm{div}\,\vec{E}$ as given.

Influence of the inverse operator $\partial_0^{-1} = \int \mathrm{d}\,t$ upon the second equation from (8) whose right part is the zero vector, creates again the equivalent system

$$\begin{cases} (\hat{\partial}_0^2 - \Delta)\vec{E} = -\dfrac{1}{\varepsilon}\mathbf{grad}\rho, \\ (\hat{\partial}_0^2 - \Delta)\vec{H} = \dfrac{1}{\mu}\vec{g}(x, y, z). \end{cases} \tag{9}$$

In (9), vector function $\vec{g}(x, y, z)$ is the integration result determined by the physical viewpoint of the concrete engineering problem statement.

It is clear that (9) can be written as the common vector wave PDE regarding field intensities $\vec{E}$ and $\vec{H}$

$$(\hat{\partial}_0^2 - \Delta)\vec{F}_k = \vec{f}_k, \ (k = 1, 2); \ \vec{F}_1 = \vec{E}, \ \vec{F}_2 = \vec{H}; \ \vec{f}_1 = -\frac{1}{\varepsilon}\mathbf{grad}\rho,$$

$$\vec{f}_2 = \frac{1}{\mu}\vec{g}(x, y, z). \tag{10}$$

Considering (10) in the equivalent coordinate form we have the sought-for general scalar wave PDE

$$(\hat{\partial}_0^2 - \Delta)F_{ki} = f_{ki}, \ (k = 1, 2; \ i = \overline{1, 3}), \tag{11}$$

where

$$F_{1i} = \{E_i\}_{i=1}^3, \ F_{2i} = \{H_i\}_{i=1}^3; \ f_{1i} = -\frac{1}{\varepsilon}\partial_i\rho, \ f_{2i} = \frac{1}{\mu}g_i(x, y, z), \ (i = \overline{1, 3});$$

$$\mathbf{grad}\rho = \begin{bmatrix} \partial_1\rho(x, y, z, t) \\ \partial_2\rho(x, y, z, t) \\ \partial_3\rho(x, y, z, t) \end{bmatrix}, \ \vec{g} = \begin{bmatrix} g_1(x, y, z) \\ g_2(x, y, z) \\ g_3(x, y, z) \end{bmatrix}. \tag{12}$$

Solution of (11), (12) is done similarly to [8], regardless of boundary conditions and using integral transform method by all spatial variables (x, y, z) [7]. Supported by the technique of [8], the general wave PDE (11), (12) becomes the second order ODE (ordinary differential equation)

$$\left(\frac{\mathrm{d}^2}{\mathrm{d}t^2} + \frac{\sigma}{\varepsilon}\frac{\mathrm{d}}{\mathrm{d}t} - \frac{\Delta_{tr}}{\mu\varepsilon}\right)_{tr}F_{ki} =_{tr} f_{ki}^*, \ (k = 1, 2; \ i = \overline{1, 3}). \tag{13}$$

In (13), all symbols are of the same meaning as in the following formulae from [8]

$$\int_{a_i}^{b_i}(\partial_i^2 F)K_i(x_i, p_i)\,\mathrm{d}x_i = (K_i(\partial_i F) - (\partial_i K_i)F)\,|_{x_i = a_i}^{b_i} + \int_{a_i}^{b_i}(\partial_i^2 K_i)F\,\mathrm{d}x_i =$$

$$= s_i(p_i, x_\nu \ (\nu \neq i; \ \nu = \overline{1, 3}); t) + \eta_i(p_i)_i F_{tr}, \ (i = \overline{1, 3}); \tag{14}$$

$$s_i = s_i(p_i, x_\nu \ (\nu \neq i; \ \nu = \overline{1, 3}); t) = (K_i(\partial_i F) - (\partial_i K_i)F)\,|_{x_i = a_i}^{b_i} =$$

$$= s_i(p_i, x_\nu, x_l, t), \ (\nu, l \neq i; \ l > \nu); \tag{15}$$

$$ {}_i F_{tr} = {}_i F_{tr}\,(p_i,\ x_\nu\ \ (\nu \neq i;\ \ \nu = \overline{1,3});\ t) = $$

$$ = \int_{a_i}^{b_i} F(x_i\ (i = \overline{1,3}); t) K_i(x_i, p_i)\,\mathrm{d}\,x_i = \int_{a_i}^{b_i} F K_i\,\mathrm{d}\,x_i,\ \ (i = \overline{1,3}); \qquad (16) $$

$$ F_{tr} = F_{tr}(p_i\ \ (i = \overline{1,3}); t) = F_{tr}(p,t) = \left(\prod_{\substack{\nu=1 \\ \nu \neq i}}^{3} \int_{a_\nu}^{b_\nu} K_\nu\,\mathrm{d}\,x_\nu \right) {}_i F_{tr} $$

$$ = \int_{a_l}^{b_l} \int_{a_\nu}^{b_\nu} K_\nu(x_\nu, p_\nu) K_l(x_l, p_l)\, {}_i F_{tr}(p_i, x_\nu, x_l, t)\,\mathrm{d}\,x_\nu\,\mathrm{d}\,x_l, $$

$$ p = \bigcup_{i=1}^{3} p_i = (p_1, p_2, p_3),\ (i = \overline{1,3}); \qquad (17) $$

$$ \Delta_{tr} = \Delta_{tr}(p) = \sum_{i=1}^{3} \eta_i(p_i);\ \ f_{tr}^{*} = \tilde{f}_{tr} - \sum_{i=1}^{3} \left(\prod_{\substack{\nu=1 \\ \nu \neq i}}^{3} \int_{a_\nu}^{b_\nu} K_\nu\,\mathrm{d}\,x_\nu \right) s_i, $$

$$ (i = \overline{1,3});\ \tilde{f}_{tr} = \frac{f_{tr}}{(\mu_a \varepsilon_a)^2}, \qquad (18) $$

where $x = x_1,\ y = x_2,\ z = x_3$; the i th integral transform kernel by the argument x_i with parameter p_i is written like that $K_i = K_i(x_i, p_i)$, and the direct integral transform is determined by the expression $S_i = \int_{a_i}^{b_i} K_i(x_i, p_i)\,\mathrm{d}\,x_i$ with the endpoints a_i, b_i of the open integration contour L_i, $(i = \overline{1,3})$. Those points can be either finite or infinite real or complex as well [7].

Consideration of integral transforms influence on ΔF by $(x, y, z) = \{x_i, (i = \overline{1,3})\}$, allows uniformly presenting the general scalar components of electromagnetic field vector intensities by the expression $F = F(x, y, z, t) = F(x_i,\ (i = \overline{1,3}); t)$. Then, application of the i th integral transform to $\Delta F = \sum_{i=1}^{3} \partial_i^2 F$ and double integration by parts give (14), (15). In (13), (14) and everywhere below, either the right-hand or the left-hand subscript “tr” means conversion to the corresponding transform. Though in

(15), $i, \nu, l = \overline{1, 3}$, but ν, l take only two values from those three because of two last inequalities in (15). In addition, the second summand $\eta_i(p_i)_i F_{tr}$ from the right side of (14) has the factor $\eta_i(p_i)$ dependent only on the i th integral transform parameter p_i. The mentioned factor is generated by the operation $\partial_i^2 K_i$, $(i = \overline{1, 3})$ in (14). At last, (16) describes the "incomplete" i th transform of F by variable x_i, and derives "complete" transform (17) for F by all spatial arguments $(x, y, z) = (x_i,\ i = \overline{1, 3})$. In (18), conditions for ν, l remain the same as for s_i, $(i = \overline{1, 3})$ from (15), and expression under the sign of $\sum$ in the second formula is similar to the last part of the first equality from (17). Namely,

$$\left(\prod_{\substack{\nu=1 \\ \nu \neq i}}^{3} \int_{a_\nu}^{b_\nu} K_\nu \, \mathrm{d}\, x_\nu \right) s_i = \int_{a_l}^{b_l} \int_{a_\nu}^{b_\nu} K_\nu(x_\nu, p_\nu) K_l(x_l, p_l) s_i(p_i, x_\nu, x_l, t) \, \mathrm{d}\, x_\nu \, \mathrm{d}\, x_l,$$

$$(\nu, l \neq i;\ l > \nu;\ i, \nu, l = \overline{1, 3}).$$

Generally, accurate within change of F_{tr}, f_{tr} to ${}_{tr}F_{ki}$, ${}_{tr}f_{ki}$, all symbols in (13) are of the same meaning as in (14)-(18). Inherent difference takes place only in the last expression from (18), where

$$\tilde{f}_{tr} = \frac{f_{tr}}{\varepsilon\mu}.$$

General solution for (13)

$${}_{tr}F_{ki} = {}_{tr}F_{ki}(t, p) = C_1(t, p) \exp(\omega_1 t) + C_2(t, p) \exp(\omega_2 t) \qquad (19)$$

is sought by the method of variation of constants [9], where unknown functions $C_j(t) = C_j(t, p)$, $(j = 1, 2)$ represent the solution of system

$$\begin{cases} C_1' \exp(\omega_1 t) + C_2' \exp(\omega_2 t) = 0 \\ C_1' \omega_1 \exp(\omega_1 t) + C_2' \omega_2 \exp(\omega_2 t) = {}_{tr}f_{ki}^*, \end{cases} \quad C_j' = \frac{\partial C_j}{\partial t},\ (j = 1, 2)$$

and look like

$$C_{1,2}(t, p) = \pm \frac{1}{\omega_1 - \omega_2} \int \exp(-\omega_{1,2} t) {}_{tr}f_{ki}^*(t, p) \, \mathrm{d}\, t + C_{1,2}^*(p). \qquad (20)$$

In (20), the unknown functions $C^*_{1,2}(p)$ are found basing on the corresponding transformed initial conditions of the specific boundary value problem. The latter is responsible for the mathematical simulation of the studied physical or engineering process.

It should be noted, that in (19), (20)

$$\omega_{1,2} = \frac{1}{2}\left(-\frac{\sigma}{\varepsilon} \pm \sqrt{D}\right) \tag{21}$$

are the roots of performance (characteristic) equation

$$\omega^2 + \frac{\sigma}{\varepsilon}\omega - \frac{\Delta_{tr}}{\varepsilon\mu} = 0$$

with discriminant

$$D = \left(\frac{\sigma}{\varepsilon}\right)^2 + \frac{4\Delta_{tr}}{\varepsilon\mu}. \tag{22}$$

Substitution of (20) for (19) gives the required general explicit solution of (13)

$$_{tr}F_{ki} = {}_{tr}F_{ki}(t, p) = \sum_{j=1}^{2} C_j(t, p)\exp(\omega_j t) =$$

$$= \sum_{j=1}^{2} \exp(\omega_j t)\left(\frac{(-1)^{j+1}}{\sqrt{D}}\int \exp(-\omega_j t)\,{}_{tr}f_{ki}(t, p)\,\mathrm{d}t + C^*_j(p)\right), \tag{23}$$

where ω_j, $(j = 1, 2)$ and D are determined in (21), (22). Direct check easily confirms that (23) undoubtedly represents the general solution of (13).

The further conversion to the starting wave inverse transform regarding (23) gives function

$$F_{ki} = F_{ki}(x, y, z, t) = \prod_{l=1}^{3} S_l^{-1}\,{}_{tr}F_{ki}\,,\ (k = 1, 2;\ i = \overline{1, 3}), \tag{24}$$

where S_l^{-1}, $(l = \overline{1, 3})$ are all inverse integral transforms with respect to initially used, and ${}_{tr}F_{ki}$ is from (23). Hence, explicit expression (24) is the required solution of the general scalar wave PDE (11), (12) and describes

all scalar components of electromagnetic field vector intensities. Formulae (23), (24) can be effectively used when specification of the mathematical modeling for engineering problem statement is done and appropriate exact analytic result is demanded.

Since the complete analysis and explicit solution of (1) in the class of not generalized functions are finished, and the first step of this paper's goal is attained, the effective investigation of (2) from [3] can be proposed as well.

System (2) is homogeneous. As it was recently explained for the first subsystem from (3), diagonalization of (2) should be done using operator generalization of algebraic Gauss method [4]. Operator application of **rot** and $(-i\mu_0\omega)$ to the first and second equations of (2) respectively, with the term-by-term addition of both transformed equations, reduces original system to equivalent

$$\begin{cases} (\mathbf{rot}^{\,2} + i^2\varepsilon_0\mu_0\omega^2)\vec{E} = (\mathbf{rot}^{\,2} - \varepsilon_0\mu_0\omega^2)\vec{E} = 0, \;\; i^2 = (\sqrt{-1})^2, \\ \mathbf{rot}\,\vec{E} + i\mu_0\omega\vec{H} = 0. \end{cases} \tag{25}$$

In (25), the first equation already depends on the only one electric field vector intensity $\vec{E}$. Then, influences of operators $(-\mathrm{rot})$ and $(\mathrm{rot}^{\,2} - \varepsilon_0\mu_0\omega^2)$ on the first and second equations in (25), with further term-by-term addition of both transformed equations, leads again to the equivalent system

$$\begin{cases} (\mathrm{rot}^{\,2} - \varepsilon_0\mu_0\omega^2)\vec{E} = 0, \\ i\mu_0\omega(\mathrm{rot}^{\,2} - \varepsilon_0\mu\;\omega^2)\,\vec{H} = 0, \;\; i = \sqrt{-1}. \end{cases} \tag{26}$$

In (26), now the second equation depends on the only magnetic field vector intensity $\vec{H}$. Therefore, system (26) closes diagonalization of (2) in terms of vectors. The next stage is writing of (26) in the coordinate (scalar) form using property (7). Obtaining (2), authors of [3] put $\vec{i} = 0, \; \rho = 0$ in the classical version (1). As the result, (7) degenerates into

$$\mathrm{rot}^{\,2} = -\Delta. \tag{27}$$

In its turn, (27) takes (26) to the simplified equivalent system

$$\begin{cases} (-\Delta - \varepsilon_0\mu_0\omega^2)\vec{E} = 0, \\ i\mu_0\omega(-\Delta - \varepsilon_0\mu\;\omega^2)\,\vec{H} = 0, \;\; i = \sqrt{-1}, \end{cases} \Leftrightarrow \begin{cases} (\Delta + \varepsilon_0\mu_0\omega^2)E_i = 0, \\ (\Delta + \varepsilon_0\mu\;\omega^2)\,H_i = 0, \end{cases} (i = \overline{1,3}) \tag{28}$$

dependent on all scalar components of electromagnetic field vector intensities. Basing on (28), the required general scalar wave PDE for (2) is written

$$(\Delta + \varepsilon_0\mu_0\omega^2)F_{ki} = 0,\ \ F_{1i} = E_i,\ F_{2i} = H_i,\ (i = \overline{1, 3}). \qquad (29)$$

Equation (29) is homogeneous, and partial differential operator in its left part depends only on the spatial variables (x, y, z) not taking into account temporal parameter t, which is natural corollary of the aforesaid ill-founded contingencies [3] on the classical Maxwell system (1). The last fact is the most substantial rough infringement of the original problem statement [3], which not only makes senseless further solution of (29), but in general, deprives (29) any right to be called wave. Even if research of (29) continues, after application of the above mentioned integral transform method [7] by all spatial variables (x, y, z), PDE (29) becomes ordinary algebraic

$$(\Delta_{tr} + \varepsilon_0\mu_0\omega^2)_{tr}F_{ki} = {}_{tr}f^*_{ki},\ (k = 1, 2;\ i = \overline{1, 3}). \qquad (30)$$

In (30), as in the real general transformed wave equation (13), all symbols are introduced by (14) – (18), and F_{tr}, f_{tr} change into ${}_{tr}F_{ki}$, ${}_{tr}f_{ki}$, where the subscript "tr" implies the earlier function transform by all spatial variables (x, y, z). Here, it should be noted that essential constraint in (30) is connected with (18), where expression for f^*_{tr} has $\widetilde{f}_{tr} = 0$. So solution of (30) looks like

$${}_{tr}F_{ki} = \frac{{}_{tr}f^*_{ki}}{\Delta_{tr} + \varepsilon_0\mu_0\omega^2}, \qquad (31)$$

and all unknown scalar components of electromagnetic field vector intensities are described by the preceding common formula (24), where the appropriate transforms are given by (31).

Closing analysis of basic results in [3], it is impossible not to engage the authors' idea concerning solving of (1) at the level of electromagnetic field scalar U and vector $\vec{V}$ potentials. Those functions are introduced by the formulae

$$\vec{E} = -\mathbf{grad}U - \partial_0\vec{V},\ \ \vec{B} = \mathbf{rot}\vec{V} \Leftrightarrow \vec{H} = \frac{1}{\mu}\mathbf{rot}\vec{V}. \qquad (32)$$

Further proposed approaches and calculation are done even without aforesaid restrictions [3] for the original Maxwell system (1), which is degenerated to (2) [3]. Hence, basing on (32) let all possible variants of

electromagnetic field analytic exact research be considered. The first direction is substitution of (32) for (1)≡(3). It gives the equivalent system

$$\begin{cases} (\varepsilon\partial_0+\sigma)\vec{E}-\dfrac{1}{\mu}\mathbf{rot}\,\vec{B}=0, \\ \mathbf{rot}\,\vec{E}+\partial_0\vec{B}=0, \\ ----------- \\ \operatorname{div}\vec{E}=\rho/\varepsilon, \\ \operatorname{div}\vec{B}=0. \end{cases} \Leftrightarrow \begin{cases} \mathbf{rot}(-\mathbf{grad}U-\partial_0\vec{V})+\partial_0\mathbf{rot}\vec{V}=0, \\ (\varepsilon\partial_0+\sigma)(-\mathbf{grad}U-\partial_0\vec{V})-\dfrac{1}{\mu}\mathbf{rot}^2\vec{V}=0, \\ ---------- \\ \operatorname{div}(\mathbf{grad}U+\partial_0\vec{V})=-\dfrac{1}{\varepsilon}\rho, \\ \operatorname{div}\mathbf{rot}\vec{V}\equiv 0. \end{cases} \quad (33)$$

Since $\mathbf{rot}\,\mathbf{grad}\,U\equiv\vec{0}$, $\operatorname{div}\mathbf{rot}\vec{V}\equiv 0$, $\operatorname{div}\mathbf{grad}U=\Delta$ [7], and operator commutativity in pairs $\partial_0\,\mathbf{rot}=\mathbf{rot}\,\partial_0$, $\partial_0\operatorname{div}=\operatorname{div}\partial_0$ is clear, owing to (6), (7) system (33) becomes its own equivalent

$$\begin{cases} \Delta U+\partial_0\operatorname{div}\vec{V}=-\dfrac{1}{\varepsilon}\rho, \\ \mu(\varepsilon\partial_0+\sigma)\mathbf{grad}U+(\hat{\partial}_0^2+\mathbf{grad}\operatorname{div}-\Delta)\vec{V}=0. \end{cases} \quad (34)$$

It is easy to find that not all operators in (34) commute in pairs. That's why diagonalization of (34) and its proven reduction to the general wave PDE regarding electromagnetic field potentials is unattainable.

The next variant deals with the direct substitution of (32) for the final diagonalization result of (1), – system (9)

$$\begin{cases} (\hat{\partial}_0^2-\Delta)\mathbf{grad}U+(\hat{\partial}_0^2-\Delta)\partial_0\vec{V}=\dfrac{1}{\varepsilon}\mathbf{grad}\rho, \\ (\hat{\partial}_0^2-\Delta)\mathbf{rot}\vec{V}=\vec{g}(x,y,z). \end{cases} \quad (35)$$

It is obvious that the second equation in (35) depends now on the only one vector potential $-\vec{V}$. It is left now obtaining equation dependent on the only scalar potential U. Application of **rot** on the first correspondence in (35), and of $(-\partial_0)$, – on the second one, after the term-by-term addition of both transformed equations basing on $\partial_0\,\mathbf{rot}=\mathbf{rot}\,\partial_0$, leads to the equivalent system

$$\begin{cases} (\hat{\partial}_0^2-\Delta)\mathbf{rot}\vec{V}=\vec{g}(x,y,z), \\ (\hat{\partial}_0^2-\Delta)\mathbf{rot}\,\mathbf{grad}U=\dfrac{1}{\varepsilon}\mathbf{rot}\,\mathbf{grad}\rho-\partial_0\vec{g}. \end{cases} \quad (36)$$

It is easy to notice, that both parts of the second equation in (36) are identical zeroes because of $\mathbf{rot}\,\mathbf{grad}U \equiv \vec{0}$, $\mathbf{rot}\,\mathbf{grad}\rho \equiv \vec{0}$ [7] and $\partial_0 \vec{g}(x, y, z) \equiv \vec{0}$. Therefore, (36) consists now of only one equation

$$(\hat{\partial}_0^2 - \Delta)\mathbf{rot}\vec{V} = \vec{g}(x, y, z), \tag{37}$$

whose structure is more complicated in comparison with the general wave PDE (10)-(13). Even with the given electric field intensity $\vec{E}$ in (32), the search of unknown scalar potential U from (32) with additional condition (37), appears unattainable in spite of detailed study of (37) in scalar form

$$(\hat{\partial}_0^2 - \Delta)\begin{bmatrix} \partial_2 V_3 - \partial_3 V_2 \\ \partial_3 V_1 - \partial_1 V_3 \\ \partial_1 V_2 - \partial_2 V_1 \end{bmatrix} = \begin{bmatrix} g_1 \\ g_2 \\ g_3 \end{bmatrix}, \tag{38}$$

and further complete diagonalization of (38). Since (38) is inhomogeneous, the indicated procedure can be done by the inverse matrix operator construction [5]. Remembering that uniqueness of solution for inhomogeneous algebraic system exists only with its nonzero determinant [6], we base on the operator generalization of mentioned method [5] and compute the determinant for (38):

$$\det(38) = \det\left((\hat{\partial}_0^2 - \Delta)\begin{bmatrix} 0 & -\partial_3 & \partial_2 \\ \partial_3 & 0 & -\partial_1 \\ -\partial_2 & \partial_1 & 0 \end{bmatrix} \right) \equiv 0.$$

The last expression proves the lack of unique solution for (38) and therefore, impossibility of potentials' $U, \vec{V}$ explicit construction.

The last opportunity of exact retrieval of unknown potentials $U, \vec{V}$ remains. It implies study of (32) as corresponding system with respect to unknown $U, \vec{V}$ and given electromagnetic field vector intensities $\vec{E}, \vec{H}$

$$\begin{cases} \mathbf{rot}\vec{V} = \mu\vec{H}, \\ \mathbf{grad}U + \partial_0 \vec{V} = -\vec{E}. \end{cases} \tag{39}$$

System (39) is inhomogeneous because $\vec{E}, \vec{H}$ are known here. Hence, as in the preceding case, (39) has the unique solution with its nonzero determinant. Unfortunately, even for (39), the explicit seek of the field

potentials $U, \vec{V}$ is impossible because determinant of this system is identical zero

$$\det(39) = \det\begin{bmatrix} 0 & \mathbf{rot} \\ \mathbf{grad} & \partial_0 \end{bmatrix} \equiv 0,$$

basing on $\mathrm{rot}\ \mathrm{grad} \equiv \vec{0}$ [7].

Analysis of all obtained here results confirms appropriateness and efficiency of those two proposed exact methods [4], [5] used for explicit electromagnetic field study. Ungrounded restrictions concerning "rough" physical / mathematical simplification of the original fundamental statement break connection between investigations of real engineering phenomena and correct analytic solution of corresponding applied problems [3].

Finally, further support of procedures [4], [5] evokes comparison of [5] with its application to (1) when the charge density $\rho = \rho(x, y, z, t)$ is a fortiori indeterminate. Then the first equation from (5) basing on (7) can be written in scalar form

$$\begin{cases} \widehat{A}_{23} E_1 + B_{12} E_2 + B_{13} E_3 = 0, \\ B_{12} E_1 + \widehat{A}_{13} E_2 + B_{23} E_3 = 0, \\ B_{13} E_1 + B_{23} E_2 + \widehat{A}_{12} E_3 = 0. \end{cases} \tag{40}$$

System (40) looks almost like analogous result in [5], accurate within zero right sides of equations and change of operators $\widetilde{A}_{ij}$ into

$$\widehat{A}_{ij} = \widehat{\partial}_0^2 - \Delta + \partial_i^2, \ (i = 1,\ 2;\ j = 2,\ 3;\ i \neq j), \tag{41}$$

where $\widehat{\partial}_0^2$ is denoted by (6). Operators $B_{ij} = \partial_i \partial_j$, $(i = 1,\ 2;\ j = 2,\ 3;\ i \neq j)$ are here the same as in [5].

Application of unifying technique [4] to homogeneous operator systems, takes (41) to the general wave PDE with respect to all scalar components of electric field vector intensity $\vec{E}$

$$\widehat{\partial}_0^2 (\widehat{\partial}_0^2 - \Delta) E_i = 0 \quad (i = \overline{1,\ 3}). \tag{42}$$

Solution of (42) is done similarly to (10) using the integral transform method [7]. Introduction of new function

$$\Phi_i = \Phi_i(x, y, z, t) = \widehat{\partial}_0^2 E_i, \ \ (i = \overline{1,\ 3}) \tag{43}$$

reduces (42) to the following second-order equation

$$(\widehat{\partial}_0^2 - \Delta)\Phi_i = 0 \quad (i = \overline{1, 3}). \tag{44}$$

Instead of the original fourth-order one, we get (44) of less order. Then, in exactly the same way as in [8], at first (44) is solved and function Φ_i $(i = \overline{1, 3})$ is found. After that, (43) is considered as the particular case of (44) with $\Delta \equiv 0$, but with already given nonvanishing function Φ_i $(i = \overline{1, 3})$ and unknown E_i $(i = \overline{1, 3})$. Analytical study of (43), identically to [8], gives all scalar components of the desired electric field vector intensity $\vec{E}$. Here, the difference consists only in $\widehat{\partial}_0^2$ from (6) and operators $\widetilde{\partial}_0^2 = \mu_a \varepsilon_a (\partial_0^*)^2 + (\sigma\mu_a + r\varepsilon_a)\partial_0^* + r\sigma$, $\partial_0^* = \partial_0 \pm \lambda$ in [8].

By analogy to (42), the general wave PDE for $\vec{H}$ is got and solved also explicitly.

4. Conclusions

Closing the article, it should be noted that the assigned task is completely fulfilled.

Actually, the suggested approach uniting those two analytic operator diagonalization methods can be applied to any type of the finite dimensional square system of operator equations with piecewise constant coefficients and invertible terms commutative in pairs.

Both proposed here methods act in the class of not generalized functions and irrespectively of the specific boundary value problem statement. Those two virtues simplify as analysis of the studied engineering or physical process, as its mathematical modeling and further explicit solution.

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NEW ECONOMY Section

NEW ECONOMIC THINKING

Carmen PASCA[*] and Magdalena ALBULESCU[**]

Abstract. *"New Economic Thinking" is a phrase embodying a call for a new way of formulating economics. The need for such a call was provoked by the financial crash of 2007 and 2008. Recognition of the urgency for such a reformulation is spreading throughout the world. At its most concrete it is embodied in The Institute for New Economic Thinking, which is a nonpartisan research and education non-profit organization based in New York. This was founded by a generous donation from George Soros who has been crying in the wilderness for many years about the need for a new way of conducting the art or science of economics. Finally his words are being heard and being acted upon. The main implications of this New Economic Thinking is that we should relax the emphasis on individualism; we should recognise the people do not have precisely defined objective functions; we should understand that constraints are not set in stone and are flexible and manipulable; and most crucially we should relax the emphasis on equilibrium – recognising that it is sometimes not unique, but, more importantly, influenced by the actions of the agents themselves.*

Keywords*: equilibrium, individualism, irrationality, rationality, reflexivity.*

1. Introduction

"New Economic Thinking" is a phrase embodying a call for a new way of formulating economics. The need for such a call was provoked by the financial crash of 2007 and 2008. Recognition of the urgency for such a reformulation is spreading throughout the world. At its most concrete it is embodied in *The Institute for New Economic Thinking*, which is a nonpartisan research and education non-profit organization based in New York. This was founded by a generous donation from George Soros who has been crying in the wilderness for many years about the need for a new way of conducting the art or science of economics. Finally his words are being heard. His main criticisms are about the present state of economics.

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2. The present state of economics

At the risk of being accused of excessively simplifying the present state, we would characterize core economics as adopting the following key components: *methodological individualism; rationality and constrained optimization; equilibrium*. The first of these embodies the idea that the decision-maker in economics is an individual. This does not mean that it is an individual human-being, but rather an individual decision-maker; it could be an individual household comprising several humans, an individual firm, an individual committee, or an individual government, for example. The 'individuality' here ties in with the second item – *rationality and constrained optimization*. Economics assumes that the decision-maker has well-defined preferences and wants to put itself into the most preferred scenario given any constraints it is under. What does economics understand by 'well-defined preferences'? Such preferences should be transitive and complete: intransitivity, as understood in a static setting, would lead to situations where there was not a most preferred scenario; incompleteness likewise. *Equilibrium* is trickier: it essentially assumes that any situation 'will' find itself in a steady state. Formally, a situation is in a state of equilibrium if there are no forces that would lead to a departure from that state: no individuals who could do better for themselves by doing something different. This implies that the individuals, in equilibrium, are in mutually consistent and compatible states. Economics assumes that individuals drive the economy, pursuing their self-interests, and that the interesting states to study are equilibrium states. So the story goes as follows: individuals take economic decisions; they take them by maximizing their own self-interest subject to exogenously given constraints; these decisions are then aggregated and the equilibrium is calculated in whatever situation we are. This determines the economic consequence.

3. The criticisms of the present state

It is difficult to know where to begin. The present state of economics is elegant, self-contained and consistent within its own rules. However, it is important to recognize how constricting these rules are. These rules constrain what economics can do and what it does do.

Let us start with the first item in our list above: *methodological individualism*. As we have noted, this means that the decision-maker is an individual (and later, with the second item) has well-defined preferences. In many circumstances this is true, but one can think of many situations in

which the decision-maker is a group of individuals: a committee, a council, a government, an international organization. There may be conflicts of interest within the groups. How does economics treat such groups? Economics normally proceeds in two stages, which ultimately lead to a decision by the group. The first stage is conceived of as being a game between the members of the group, and usually, in keeping with the third item on our list, the economist seeks a *Nash Equilibrium* of the game. Then this Nash Equilibrium is taken as the outcome of the group's decision-making. This raises many questions: first, is a Nash Equilibrium a *rational* outcome of the game? It is easy to construct games (the classic example is that of the Prisoner's Dilemma) in which all players can be better off *not* playing the Nash Equilibrium. So why does the Nash Equilibrium emerge as the 'obvious' equilibrium? The answer given by economists is that it emerges as such *because of the logic of its construction*: in it all players are doing the best for themselves *given what everyone else is doing*; it is very individualistic. But suppose we use an alternative story: that all people assume that everyone else is as clever as they are. We could then get to a mutually preferred equilibrium.

But there are deeper issues, and ones connected with social relationships and the 'rules of the game'. A committee meeting is rarely simply a mechanical application of some predetermined rules. Even if it was, there is still an interesting question of where those rules came from: presumably some earlier round of negotiation. And where did those come from? In drawing up a set of rules, social interaction between the players is crucial. Some players are more persuasive, some more aggressive. Personality matters, as well as the relationship between the players. One has to merely look at the ongoing negotiations between the Greeks and the other Euro zone members to realize that these factors are important: the outcomes of these negotiations (which will have a profound influence on the world) are not a consequence of pre-determined rules, and social interactions are important. So the idea that decision-makers are individuals is seriously flawed.

There is an also an additional consideration: individuals may not care only about themselves – they may also care about others. There are models in economics which take such considerations such as altruism, hate, envy, spite into account; no longer are such models individualistic.

At this stage we need to bring in our second item: *rationality and constrained optimization*. 'Rationality' is a tricky term, and there are many versions of it. Economists have hijacked a particularly strong form, and express their assumptions about rationality in the form of axioms. For us,

rationality is merely consistency with some given set of preferences – which implies that choice is not completely random which would make it unpredictable. This depends upon the context. Let us consider a particularly simple static decision situation in which there are three possible outcomes (*a, b, c*) that the individual may have to choose between, and the individual will be asked to choose once between two of these alternatives. Let us suppose, *ex ante*, that we do not know what those two alternatives are going to be, but we want to predict the choice whatever the two are. We need to know the individual's preferences over the various members of the set of possible outcomes. Suppose these preferences violate one axiom which economists regard as almost sacrosanct – transitivity: let us suppose that the individual says that he or she prefers *a* to *b*, prefers *b* to *c*, and prefers *c* to *a*. This implies that there is no preferred outcome from the set (*a, b, c*). But why is that a problem? If the individual is offered a choice between *a* and *b*, he or she will choose *a*; if between *b* and *c*, he or she will choose *b*; if between *c* and *a*, he or she will choose *c*. We can predict choice and there is no problem. There is a problem if we do not know the complete set of preferences; if we just know that the individual prefers *b* to *c* and prefers *c* to *a*, then without transitivity we do not know the individual's preferences between *a* and *c*. So, one of the reasons for making assumptions, using axioms, is that we can predict out-of-sample.

One area in which axioms are extremely powerful in this respect is that of decision-making under risk (as distinct from under uncertainty which we shall talk about later). In economics, the predominant model is that of *Expected Utility Theory*[1]. This is not only powerful, it is also very elegant. It leads to a simple decision rule: the decision-maker chooses the option which maximizes the utility that he or she expects to get. The story goes as follows: the decision-maker is envisaged as having to choose one from a set of risky lotteries each of which leads to one out of a set of possible outcomes with specified probabilities. We should pause at this stage and reflect on what these words imply. First, that the decision-maker can specify the members of this set; second, that he or she can attach probabilities to each member of the set. In certain contexts the first of these seems trivial: consider a roulette wheel – it seems obvious that the outcome of a spin is that the ball ends up in either a red pocket or a black pocket. In this context, attaching probabilities to these two outcomes again appears trivial – they must be ½ and ½ (unless the roulette wheel is biased).

[1] The seminal reference is Neumann and Morgenstern (1944).

Notwithstanding the fact that the roulette ball may fly off the table, this example seems to be a safe area to apply Expected Utility Theory. But most real world decisions are taken in situations where the complete set of possible outcomes cannot be specified, and probabilities cannot be assigned. What might be done about the first possibility? It seems that the only thing to do is to assume that the decision-maker ignores any possibilities outside the set. As far as the second is concerned, things are more complicated which we shall discuss shortly.

However, before we go onto to more interesting scenarios, let us briefly mention the attractiveness and the 'problems' of Expected Utility Theory. The story is simple: in evaluating a risky prospect the decision-maker uses the probability-weighted average of the utilities of the outcomes. We should also mention the 'problems' with the key axiom of Expected Utility Theory: the Independence Axiom. This states that, if the individual prefers some risky lottery A to some other risky lottery B, then he or she should also prefer a lottery which leads to lottery A with probability p or some third lottery C with probability $1-p$ to a lottery which leads to lottery B with probability p or the same third lottery C with probability $1-p$. One can see the intellectual attractiveness of this, but behaviorally it seems very suspect. Many experiments have been conducted to test this axiom – possibly the most famous being that of Maurice Allais in 1953, in which he observed Leonard Savage violating (if only temporarily) the Independence Axiom.

Suppose our decision-maker can specify the set of possible outcomes, but finds it difficult to attach probabilities to the members of this set. What might he or she do? Economists are tackling this question. One obvious solution is to assume that the decision-maker use the middle (or average) estimates of each probability, but this ignores the fact that the decision-maker is uncertain about the probabilities – the situation is one of *ambiguity* rather than of risk. The field of decision-making under ambiguity is an active one in economics[2]. For example, one model assumes that the decision-maker can specify the set of possible probabilities (for each outcome), but can do no more, and therefore, instead of maximizing expected utility (which is not unique) the decision-maker chooses the option where the worst possible expected utility is maximized. A more sophisticated model assumes that the decision-maker can not only specify the set of possible probabilities, but also attach probabilities to each member of this set.

[2] For a recent survey see Etner *et al* (2010).

This seems to us to be taking us in the wrong direction. It is taking a complex situation and making it more complex by complexifying the decision rule. Interestingly this highlights a serious problem about the way that economics is conducted. Recall the second term in our second item: rationality and *constrained optimization*. Economics assumes that decision-makers can actually implement the constrained optimization problem with which they are faced. First, it may be the case that the constraints cannot be specified completely; economists assume that they are specified precisely, but the decision-maker may not be able to state them, or they may be manipulable. Consider again the Greeks bargaining with the Euro zone: it seems clear that the constraints on Greece at the start of the negotiation have been radically changed during the course of the negotiation. Social relationships are important. Second, the constrained optimization problem may be an incredibly difficult one. It is ironic that publications in economic journals are full of complicated optimization problems, which the academic writing the article has struggled with for many months, and often the main reason for its publication is that it *is* complicated and difficult. There is an odd paradox here: the problem must be difficult to solve (for the academic), yet the man-in-the-street (the decision-maker in the model) can solve it quickly and accurately.

There has been intense experimental activity investigating whether humans can reach the optimal solution. The great joy of experiments is that the experimenter can set the objective function through the use of the payment scheme (thus controlling one of the things assumed by the theorist). Sometimes humans' behavior does appear to be close to the optimal; sometimes a long way away. Interestingly, in what appears to be a very complex situation – for example, that of a 'competitive' market, with many traders' experiments – have shown that the competitive equilibrium is often attained in a very short period of time. One wonders how it happens – is this Adam Smith's Invisible Hand? Other experiments show that in more complicated markets, equilibrium is not attained immediately and there may be bubbles and crashes. The lesson may be that, in a complex situation, decision-makers do not adopt a more complex decision rule, but rather either simplify their description of the problem and optimize with respect to the simplified scenario or adopt a simpler decision rule – one that might be called 'ad hoc'.

Buried beneath the surface of the above discussion is necessarily some consideration of the *cost of computation*. If this is taken into account, then a 'sub-optimal' decision may be better than an 'optimal' one – because it saves on the cost of computation. However, note that this cannot

be modeled: if there is a cost to computation, then the decision-maker must first decide whether it is worth doing the computation; but, in order to decide that, the decision-maker must decide whether it is worth the cost of the computation required to decide whether it is worth the cost of computation; and so on – an infinite regress. Economists would be trapped inside their concept or rationality.

Let us return to our discussion of well-defined and rational preferences, and let us consider dynamic decision problems. In these decisions taken today have consequences not only for today but also for tomorrow. Preferences have to be defined over outcomes at all points in time. Defining rationality here is more difficult. Economists are guided by the principle that preferences here have to be *dynamically consistent*. What this means will take a moment to describe, and let us restrict ourselves for the moment to decision problems under risk. Consider a dynamic decision problem in which the decision-maker has to take a decision at various points in time, and interleaved with these decisions are 'moves by Nature' – probabilistic moves. There are two ways that the decision-maker could solve this problem – which are called the Strategy Method and the Backward Induction Method. The Strategy Method involves specifying a set of *conditional* decisions at each decision point, where the conditioning is on the move by Nature. Backward Induction works, as its name suggests, by working backwards, starting at the final decision date, deciding the best decision at all final decision points, eliminating the unchosen routes, and then working back in this manner to the first decision point. Dynamic consistency requires that both ways of finding the solution actually end up with the same solution. Consider what might happen if this were not the case: at each decision point the two methods would suggest different decisions. Which should the decision-maker choose?

One can see from this why dynamic consistency is attractive to economists, but note that it severely restricts behavior. We all know people who today plan to do something tomorrow, but, when tomorrow comes, actually do something different. It may be interesting to point out that dynamic consistency in a risk context requires that the individual has Expected Utility preferences, and we have already seen the problems with that. (As an unimportant footnote: dynamic consistency in a non-risky setting requires that the individual has exponential preferences).

Let us now turn to *equilibrium*. Even in a static setting, the assumption that equilibrium is attained (and that economics starts from there) is a difficult one. It requires that everyone is taking the best decision for them, given the decisions of others. Proponents of the use of the

concept of equilibrium would argue that disequilibrium must necessarily be a passing phenomenon: self-interest would soon restore it. Well, of course, in a static setting (where we started this paragraph), it is meaningless to talk about adjustment processes. In a static setting, individuals are born, take a decision, reap the consequences, and then die. So how can it be that we get to equilibrium straight away? In an interactive setting, each individual, when deciding what to do, has to predict the constraints that they will be facing, and these may be determined by the decisions that others are taking. In equilibrium there is no problem, but out of equilibrium, there is a problem.

In a dynamic context, things are different, as there is time to adjust. But, even here, economics assumes equilibrium. The logic now becomes trickier. Consider a dynamic decision problem, in which what individuals do today affects what is possible tomorrow. In order to take the best decision today, one must correctly predict what will happen tomorrow. As we have already discussed, economists, in an individual context, solve this problem by either assuming that individuals backwardly induct (from the end of the time period of the problem) or that they find the strategy solution and resolutely implement that solution even if they want to change their minds during the playing-out of the problem. In a market context, things are even more complicated: individuals have to correctly predict what possibilities the market will offer in the future. Economists close their models by assuming *rational expectations*: in which expectations are correct on average. In order to do this with most realistic dynamic stories – in which there is no endpoint – individuals must base their predictions on some model of the future. In economics, this model is an economic model, which almost certainly incorporates rational expectations. So if all individuals trust the theory then their expectations will be self-fulfilling. If not, not.

At this point, we need to bring in George Soros. In an article (Soros 2013) in the *Journal of Economic Methodology* he writes

" … if investors believe that markets are efficient then that belief will change the way they invest, which in turn will change the nature of the markets in which they are participating (though not necessarily making them more efficient). That is the *principle of reflexivity*".

This is a crucial point, which we have effectively ignored until now: economic agents, by their very actions, change the world in which they live. We cannot, as the economic paradigm described above implicitly adopts, assume exogeneity of the environment in which the agent is operating. Notice what is given in that description: the preferences of the

agents, and the constraints which they are facing. We should now discuss each of these.

We have assumed that preferences are given, but in the real world preferences change, sometimes as a consequence of social interactions with others, and sometimes because of advertising and marketing; economists prefer to ignore the latter. Preferences could change through the decision-making process itself, as a consequence of it.

The assumption that constraints are given is even more tenuous. We have already given examples relating to the Greek crisis, but examples exist everywhere. Constraints are not rigid; income constraints are not set in stone: if one is short of money one can borrow, if one is very short one can borrow more. An economist would respond that this can be built into the specification of the problem in the first place – one can expand the model. But the correct expansion depends crucially on how the decision-maker perceives the constraint: he or she may be unaware of, or morally against, going to pay-day loan operators. Note that this makes the model more complex and returns us to our earlier discussion of complexity. We firmly believe that economists have yet to think seriously about the issue of complexity.

Also institutions are not fixed and the constraints they imply are not fixed. A clear example is the reaction of the monetary authorities to the financial crisis of 2007 and 2008: they changed the rules under which markets could operate. They introduced more surveillance and more regulation. They broke up large financial institutions. One wonders if these changes had been anticipated by the market traders. More importantly, could they have been? The bottom line seems to be: expectations of what might happen in the future cannot be rational; they cannot be probabilistic; they are necessarily uncertain or ambiguous.

Let us return to Soros and his use of the idea of reflexivity[3]. This we quoted above; it is intimately related to the idea of fallibility which he describes as follows:

"The first is that in situations that have thinking participants, the participants' views of the world never perfectly correspond to the actual state of affairs. People can gain knowledge of individual facts, but when it comes to formulating theories or forming an overall view, their perspective is bound to be either biased or inconsistent or both. That is the *principle of fallibility*".

[3] Many authors have discussed reflexivity, including Soros. Other references are Touraine (1995) and several articles in a special issue of the *Journal of Economic Methodology* (2013).

So we have imperfect humans operating in an imperfect world. Their imperfect decisions have an effect on the world about them. This effect is necessarily largely unpredictable.

4. Conclusion - Where should economics go now?

We should relax the emphasis on individualism; we should recognize the people do not have precisely defined objective functions; we should understand that constraints are not set in stone and are flexible and manipulable; and most crucially we should relax the emphasis on equilibrium – recognizing that it is sometimes not unique, but, more importantly, influenced by the actions of the agents themselves.

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„APPLICATION OF LEM2 ALGORITHM IN IDENTIFICATION OF RELATIONSHIPS BETWEEN THE SIZE OF GENERAL GOVERNMENT SECTOR AND THE ECONOMY"

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Abstract. *The article is dedicated to research on relationship between size of general government sector and economy, which identification was conducted by application of LEM2 algorithm. The article is based on 18 variables that were selected for examination and that describes economy as well as on 15 variables describing sizes of the general government sector. Mentioned variables were tested basing on a sample of EU Member States on the period covering years 2000-2013. The collected statistical data were used to develop a set of economic data and set of data that present size of the general government sector. Acquired this way sets of data omit a characteristics of particular states and collected data were used to identify relationships between the size of the sector and the economy, while maintaining the distribution of the individual included in the study years and while separating pairs of variables identified in terms of the relationship between the size of the general government sector and the economy. Obtained this way matrix allowed to determine which variables remain together in a relationship and which among selected to research ratios, presenting size of the sector, did not indicate on relationship with economic variables in examined period or eventually indicated the relationship very rarely. Conducted analysis allowed to determine which variables describing the size of the general government sector should be included to study on relationship on the line: the size of the general government sector - the economy, and which of them should be omitted due to the minimal relationship with economic variables.*

JEL classification
E62, H11, H20, H50, H60,

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1. Introduction

The scientific-term of the public sector and its relationship with the economic situation of the country in respect to which it is analyzed, remains a research objective that is conducted for several years. Despite of this fact, we can observe ongoing and endless discussions on the topic of the size of the public sector as a whole, as well as its individual components that are included in the general government sector. When we add to this mater the facts of diversified research methodologies that are used by various authors, different spread of accents in relation to identified issues, or finally discrepancies in obtained results – all of these factors justify initiating new and verification of completed research work on the issues that are mentioned above.

According to the title of the article, research objective is to determine the relationship between the size of general government sector and the economy. In relation to research goal that were set this way, the work on this article started with selection of variables used to describe the economy. The variables selected for the study were based on measures commonly used in macroeconomics, in order to illustrate the economic condition of the particular country. They were also selected according to criteria of their availability in statistical databases used for purpose of the study, including the review of selected EU Member States and maintaining data continuity over time. Criteria for variables selection had therefore objective character and were largely dictated by the availability of statistical material.

Far more difficult issue was to select set of variables that describes the size of general government sector in reliable way. Analysis of the research studies showed that the issue of approaches to measurement of the general government sector's size was repeatedly mentioned in the literature. Similarly often, as attempts to measure, the literature shows objective insights on the factors obstructing to lead international comparisons, which are aimed on examination of the size of the public sector and the general government sector. Among the raised arguments that indicate mentioned above difficulties referred, there are inter alia lack of consistency in the way the statistical data is collected in individual countries, as well as the way the data is disaggregated (Mandl et al. (2008) and Curristine et al., (2007), and the diversification of obtained results of conducted research that link the size of the sector with the results of the economy, depending on the structure adopted for examination of components (generic categories) of public spending (Tsouhlou & Mylonakis (2011) and Skica (2014). Indicated difficulties, determine from

the very beginning what is the scope of the variables describing the sizes of general government sector that can be adopted in author's research. Natural criteria of its selection are two attributes: 1) the high level of aggregation, 2) the geographical and temporal availability.

Based on the above constraints of objective, as the next step in research on explaining the analyzed relationship, the authors conducted literature review on identification of measurements of the size of the public sector and the general government sector, which were used in research dedicated to the issues of trade and economic sector. Conducted analyzes confirmed just on the beginning that mentioned above multitude of parameters that are used in describing and analyzing public sector are proper, thus it proved the hypothesis that was raised on the beginning of the article. Additional regularity that revealed the results of the research, was the possibility of grouping used-in-literature measures of the size of the public sector and the general government sector, in several groups. The first of them were the measures that were based on the public expenditure, which was defined in various ways. The second group was formed by income measures. On the other hand, the last generic category should include other indicators of the size of the sector, both those based on employment statistics and these taking into account the effects of activities sector entities.

One of the most frequently used spending measures is ratio that is called total public (general government) spending (expenditure / outlays), which is given in nominal values. This ratio appears in the literature incessantly from eighties of last century, but it exists alos in older papers. One of the first authors that used this sector's measure was Cameron (1978) and Saunders (1984), as well as Bairam (1988) and Conte & Darrat (1988). This ratio appeared also in papers of following authors: Hansson & Henrekson (1994) and Gwartney et. al. (1998). Presented above measure was also applied in further researches. It was used by Franz (2003) and Peters & Verrinder (2003), as well as Chobanov & Mladenova (2009) and Colombier (2009). The measure called total public spending can be also found it current research works and scientific documents of following authors: De Witte & Moesen (2010), Afonso & Furceri (2010) and Bergh & Karlsson (2010), as well as Labonte (2010), Bergh & Henrekson (2011) and Churchill et. al. (2015). It can be assumed that presented measure of sector's size is found as the most common ratio that is used in researches dedicated to measure size of the public sector and general government sector. Next to the measure of the total public expenditure, there is one ratio that is used equally often, so the ratio that is greatly less capacious

than the category total public spending but by this more precise. This ratio is called nominal government Expenditure as % of GNP (or GDP). We can find this measure in the papers of following authors: Marlow (1986), Marlow (1988), Barth & Bradley (1988) and Peden & Bradley (1989), as well as Carlstrom & Gokhale (1991) Engen & Skinner (1992) and Yavas (1998). The ratio government nominal expenditure as % of GNP (or GDP), as a exponent of sector's size, was also employed by Fölster & Henrekson (2001), Dar & Amirkhalkhali (2002), as well as Dilrukshini (2002), Scully (2002) and Bose et. al. (2003), Ramayandi (2003) and Hjerppe (2003). Presented ratio was also used in research tests of following authors: Afonso et. al. (2005), Kustepeli (2005), Yuk (2005), or Jiranyakul & Brahmasrene (2007). Finally, among authors of newest researches, where presented ratio was used, we can list: Magazzino & Forte (2010), as well as Ruta et. al. (2012), Di Liddo et. al. (2015) and Georgiou (2015). What is important, in contrast to ratio called government nominal expenditure as % of GDP, there is ratio called real government expenditure as % of GDP that is used in research much more rarely. In period under examination this ratio was used only by two authors, i.e. Peltzman (1980), and Marlow (1986) and Marlow (1988). Due to this fact, the spending measure of general government sector that is given in real values, is clearly lagging behind its nominal-value counterpart.

An important role in measuring the size of the public sector and the general government sector is taken by the approach based on nominal government consumption expenditure as % of GDP. This approach is used in the literature as often as the nominal measure called total public spending. In the eighties of the twentieth century, it was used by following authors: Landau (1983), Ram (1986), Barth & Bradley (1988) and Grier & Tullock (1989). Then, in a bit further period, this ratio was used by Carlstrom & Gokhale (1991), Levine & Renelt (1992) and Lin (1994) Guseh (1997), and Vedder & Gallaway (1998). The autors from twenty-first century referred to this ratio in even greater intensity. After the year 2000, it was used in the works of such authors as: Bose et. al. (2003) and Ramayandi (2003), and Hjerppe (2003), Chobanov & Mladenova (2009) and Gunalp & Dincer (2005), Afonso & Jalles (2011), and Churchill et. al. (2015). Another, identical in structural sense measure – real government consumption expenditure as % of GDP (or GDP per capita), is characterized by significantly less frequent use. It was employed by, among others, Summers & Heston (1980), Barro (1989), Barro (1991); Easterly & Rebelo (1993), Sheehey (1993), and finally the Gift & Amirkhalkhali (2002) and Josheski et. al. (2011).

Next three measures of sector's size, which are used in literature are: 1) government final consumption expenditure (nominal); 2) current disbursements of government (nominal)[1]; and 3) total outlays of government include current disbursements plus gross capital formation (nominal). Presented sector's measures appeared in papers of following authors: Korpi (1985), Aleksander (1990), as well as Dublin et. al. (2003), Mink (2003), Peters & Verrinder (2003) and Pritchard (2003). Contrary for measures of consumer expenditures (i.e. current spending), are the expenditures that have investment character. The measure called central government investment expenditure as % of GDP, was used in research on measuring sector's size by inter alia: Barth & Bradley (1988), Easterly & Rebelo (1993) and Illarionov & Pivovarova (2002) and Ramayandi (2003). As an alternative for presented measure, the authors as Easterly & Rebelo (1993) and Hjerppe (2003) employed in their papers following ratios: 1) general government investment expenditure as % of GDP; 2) gross real public investment as % of real GDP; and 3) total consolidated public investment (nominal).

Beside the above sector's measures that has aggregated character (i.e. give the overall value of public spending, possibly presenting its structure divided into current and investment expenditures), the literature relating to the measurement of the size of the public sector and the general government sector also refers to the disaggregated measures of government expenditures, which express public expenditure in terms of categories of economic groups: government provision of goods and services, defense, education, subsidies to industries etc. This scientific approach to research on sector's size was used by inter alia: Friedland & Sanders (1983), Levine & Renelt (1992), as well as Easterly & Rebelo (1993), Hansson & Henrekson (1994) and Lin (1994). The disaggregated measures are also used in further research of authors as: Vedder & Gallaway (1998), Heitger (2001), or Romero-Avila & Strauch (2008). By analyzing spending of different economic groups, the other regularity should be noted. The transfer expenditures including social spending, due to their specificity, are found as spending category that is expressed in separation against other economic groups of public spending. Level of public transfer payments (including social security expenditure) is found as a measure of the size of public sector and general government sector, in the papers of following authors: Friedland & Sanders (1983), Korpi (1985), and Barth & Bradley (1988). Spending on social security and wider for transfer payments were

[1] Includes final consumption expenditure but also interest on the public debt, subsidies and social security transfers to households (Korpi, 1985).

also used by other authors in the researches on measurement of sector's size. They were used by both Easterly & Rebelo (1993) and Hansson & Henrekson (1994). This measure finds its application also in newest researches that are dedicated to problems mentioned above. It was employed by inter alia: Franz (2003), Dublin et. al. (2003), Mink (2003), as well as Peters & Verrinder (2003), Adema & Ladaique (2003) and Labonte (2010).

As it was found in conducted literature review, the expenditure measures of public sector and the general government sector are an extensive and diverse set of indicators. Among them, we can clearly stand out certain ratios that have common application, but from the other hand we can unambiguously identify some ratios from their background that can be used is merely episodic nature. The collected information will be applied to select variables representing a canon in the analyses dedicated to measure sector's size. They will also enable authors to propose a (supplementary) set of indicators, using which the authors will realize the objective of this study.

Another group of indicators of the public sector's size and the general government sector's size are the so-called income measures. These measures accounted for fields of activity of different specify of interpretation than expenditures. The expenses were the fields of activity of the general government sector perceived through the prism of amounts spent for specific objectives or groups of objectives i.e. were related with realization of public tasks and justified economical role of public sector. From the other hand, the incomes of general government sector are the exponent of the degree to which state interferes in the economy acquiring directly or indirectly part of the funds from the society – thus prevent the possibility of providing public services, but at the same time funding the operating costs of the state. While the first of the objectives is understandable – public expectations concerning the activity of the state for the benefit of its citizens must be associated with their participation in the operating costs of the state, the second of the mentioned dimensions is much more debatable. As indicated at the outset, unresolved problem is the answer for the question on optimal size of the general government sector from the point of view of the economy and the society. It is this fact that has become one of the causative factors for initiation of this research (and this article) by demonstrating compounds on the line: the size of the general government sector – the economy, is a first step towards further work dedicated to explain the outlined above research problem.

While the measure based on total public expenditure is often used as an exponent of the size of the general government sector and the entire public sector, whereas its counterpart on the revenue side, i.e. the indicator called government revenue as% of GNP (or GDP), it is not a widely used measure. Literature review indicated that only two authors used it in the past: Rubinson (1977) and Korpi (1985). We can observe analogical situation in relations to ratio called disaggregated measures of government revenue, which takes into account particular categories of public revenues, and ratio called government fiscal surplus as a % of GDP. The first way of expressing the size of the sector was used only in the paper of Romero-Avila & Strauch (2008), and the second ratio was used in study of Levine & Zervos (1993). The presented findings do not reject the idea of using income-based measures presented in the literature. The explanation for these findings can be however found in certain shift in scope of expressing the size of the general government sector and the entire public sector of the revenue side, towards measures based on taxes. The measure called total tax revenue as a % of GDP was employed in scientific works of following authors: Rabushka (1985) and Koester & Kormendi (1989), as well as in papers of Fölster & Henrekson (2001), Franz (2003), Adema & Ladaique (2003) and Chobanov & Mladenova (2009). From the other hand, the ratio called average tax rates as a measure of sector's size, was applied in the articles of Engen & Skinner (1992), as well as Agell et. al. (1997) and Pritchard (2003). The last from the group of tax-based sector's measures, is the ratio called total tax revenue (nominal), which was used in the researches of Hjerppe (2003), Agell et. al. (2006) and Colombier (2009); as well as Afonso & Furceri (2010), Bergh & Karlsson (2010) and Labonte (2010) and Bergh & Henrekson (2011).

As it was found, measures of income are much less capacious, and at the same time much more strongly focused category of indicators of the size of the general government sector. As a result, their use in research is much smaller, what in practice means that they have definite advantage in the way of expressing the size of the sector by usage of expenditure measures.

The last group of indicators of size of the general government sector and the entire public sector constitutes the most diverse category due to its structure. However, to a large extent it consists of measures, which are applicable in single research studies. An ideal example of this is a ratio called share of the public budget in total output (in %) employed by

Bajo-Rubio, (2000), later ratio called output / production ratio of government (nominal) used by Franz, (2003) and Mink, (2003), as well as central government surplus (consolidated public sector surplus) as a % of GDP, used by Easterly & Rebelo (1993). There are two ratios of size of the general government sector that present in the similar way. These are: share of assets owned by government in total national assets (in %) employed in the papers of Illarionov & Pivovarova (2002) as well as sale of state assets (nominal) used in the papers of Dublin et. al., (2003) and Chobanov & Mladenova (2009). Measures based on the results of the activities of the sector are characterized by slightly more often application in research studies. The measure called gross value added (nominal or as % GDP), was used by Peters & Verrinder (2003) and Pritchard (2003), and ratio called gross fixed capital formation (nominal), found its application in the papers of following authors: Aleksander (1990), Easterly & Rebelo (1993), as well as Heitger (2001), Dar & Amirkhalkhali (2002) and Dublin et. al. (2003). The authors observed rare application of measures of the size of the general government sector based on the outcome of the state budget and the entire sector. Central government deficit (nominal) as a measure of the sector's size was used by Aleksander (1990), and ratio called general government deficit as a % of GDP was used as a measure of sector's size in the papers of following authors: Franz (2003), Mink (2003) and Peters & Verrinder (2003). Next measure that similarly to previously mentioned ratios was not employed very often was: government financial balance (ratio of government receipts minus outlays) as a % of GDP used in scientific work of Dar & Amirkhalkhali (2002). We can observe similar situation in relations to ratios based on public debt. General government net lending (nominal), as a sectors measure, was used only by Chobanov & Mladenova (2009), and ratio called public debt as a % of GDP, as a measure of sector's size was used in papers of following authors: Franz (2003), Mink (2003) and Peters & Verrinder (2003). The last measures that describe size of public sector and size of general government sector, are these ratios that are based on employment. First of them is public sector (or general government sector) employment, and second is share of employees in the public sector (or general government sector) in overall employment. Both ratios are interchangeable employed by the research papers of following authors: Gupta et. al. (2001), as well as Illarionov & Pivovarova (2002), Hoffmann (2003), McTigue (2004) and Mitchell (2005) and Köllő (2014).

Presented above group of variables has two characteristics. These include a large diversity of approaches to measure the size of the sector and a large number of individual (not continued) occurrences in papers dedicated to topic under examination. It can therefore be assumed that the measures included in this category are worse than two previously presented groups (and in particular worse than spending measures).

The research findings, which were obtained basing on analysis of three groups of indicators of the sector size, served to designate a catalog of variables describing the size of the general government sector and a catalog of variables describing the economy. From one hand, they take into account used in the literature research approach, and from the other they pose as approach of authors to select variables to explain the relationship between the size of the general government sector and the economy.

2. Structure and scope of variables adopted for research

The process of research started from selecting quantitative variables for presenting the size of the general government sector and variables that serve the description of the economy. Analysis of literature and research work, which was done in first part of this article, as well as the experience of the authors that is a consequence of previously completed research devoted to the general government sector and the entire public sector, allowed selecting 18 variables for economy description (see. Table 1), and 15 variables for description of the size of the general government sector (see. Table 2). The subject of research of this article is the economies of EU Member States, as well as their public finance systems. The research covers the years 2000-2013 (inclusive), with exclusion of year 2001, which due to numerous data gaps in official statistics was eliminated from the research. The data presented (as set out in Tables 1 and 2), included both measures given in absolute terms and in relative terms (percentages), and their sources were various statistical data included in the systems of statistical reporting Eurostat, OECD and the World Bank. The selected source of statistical material satisfy the conditions: continuity of data access, unified manner of their presentation, availability of resources and the unification of historical data figures. Because of that, results presented in this article can be effectively expanded and continued, as well as referred to the historical data.

Table 1.

Variables describing the economy.

No	Name	Unit
1	External balance of goods and services	Million Euro
2	Gross Domestic Product in current prices (per inhabitant)	GDP per inhabitant
3	Production in industry – dynamic	Percentage change compared to same period in previous year
4	Balance of the current account	Million Euro
5	Potential output of total economy	Million Euro
6	Harmonized Indices of Consumer Prices (HICPs)	Annual average rate of change
7	Inward FDI flows	Million USD
8	FDI (Foreign direct investment)	Million USD
9	Real effective exchange rate	Index 1999 = 100
10	Human Development Index – HDI	Value from 0 to 1
11	Outward FDI flows	Million USD
12	Growth rates of GDP (percent)	Percentage change
13	Gross capital formation (% GDP)	% GDP
14	Gross Domestic Product in current prices (per inhabitant) – dynamic	Percentage change
15	Activity rate	in %
16	Retail sales – dynamic	Index of turnover – Total 2010 = 100
17	Potential output of total economy – dynamic	Annual average rate of growth – percentage
18	Unemployment rate	in %

Source: Own work.

Table 2.

Variable describing size of general government sector.

No	Name	Unit
1	General Government gross capital formation (% GDP)	% GDP
2	Government consolidated gross debt (% GDP)	% GDP
3	Public sector employment	Number of people
4	Total General Government Expenditure (euro per inhabitant)	euro per inhabitant
5	Total General Government Revenue (euro per inhabitant)	euro per inhabitant
6	Net lending/ borrowing	Million Euro
7	Total General Government Expenditure (% GDP)	% GDP

8	Central government deficit (% GDP)	% GDP
9	General Government Sector Output (% GDP)	% GDP
10	Gross value added or General Government total value-added	basic (current) prices
11	The ratio of total taxes to GDP	% GDP
12	Final consumption expenditure	% GDP
13	General government deficit (% GDP)	% GDP
14	Total General Government Revenue (% GDP)	% GDP
15	General government Gross fixed capital formation (% GDP)	% GDP

Source: Own work.

Variables selected for the research that describe the economy as well as variables presenting the sizes of general government sector, are the a set of ratios considered as canons of macroeconomic measures, which were additionally expanded by the authors by the variables that constitute author's approach to explain the examined dependence. Thus, the selection of variables was purposeful and fully complying with the characteristics analyzed in the study on relationship between the size of the general government sector and the economy. The article presents the same added value, acting to test examined dependency of these variables, which were not used in the studies dedicated to identify a compound the size of the general government sector and the economy.

Since the main goal of the authors was to find the relationship between the size of the general government sector and the economy in general meaning, during the research the countries were not dealt with individually, but taking into consideration global situation of all of them. This does not however mean that the information has been omitted, as each row in the input table is information about the economic situation of the country. Due to the fact that collected data was incomplete and contained minor errors and anomalies, in the first stage of research the data was to be cleaned and processed. Among the collected data describing the economy, they were also those for which not all values were given. Therefore for further studies, there were accepted only those variables for which the missing values are less than 1/3 of all values. To supplement the missing values, the authors general additive models, in particular the method of K-nearest neighbors.

The initial values of variables describing both general government sector and the economy of the studied countries were continuous. In order to standardize the values of those variables, the digitalization was adopted.

During the process of discretization for the continuous attributes are replaced with discrete values, which corresponded to a certain interval of continuous values of the original attribute. These compartments are arranged, which makes that authors obtained original attribute with finite number of values, instead of continues attribute. In order to discretize the data, the authors used the method of allocating the value of each variable in such a way that each of them had exactly the same fixed number of intervals, and then authors assigned to variables a new discrete values. This method makes the new discrete values will decompose evenly. Using the above solution, the authors adopted three compartments discretization: 4, 6 and 8. The research leading to the emergence of the best classifier was carried out on each of these groups in parallel.

3. Research methodology

There is a number of methods and algorithms, which can be used in data analysis. The authors of this research focused on rule-based approach, especially on LEM2 algorithm, which is commonly used to create learning models in the form of rules generated from data tables. D*ecision rules* are "if-then" rules that describe certain characteristics of combination between values of condition attributes and decision attributes. Among the various decision rule generation methods we have chosen the LEM2 algorithm (Grzymala-Busse, 1992). LEM2 explores the search space of attribute-value pairs. Its input data set is a lower or upper approximation of a concept, so its input data set is always consistent. In general, LEM2 computes a local covering and then converts it into a rule set.

The LEM2 algorithm is based on an idea of an attribute-value pair block. Let U be the set of all cases (examples) of the data set. For an attribute-value pair $(a,v)=t$, a block of t, denoted by [t], is a set of all cases from U such that for attribute a have value v. Let B be a nonempty lower or upper approximation of a concept represented by a decision-value pair (d,w). Set B depends on a set T of attribute-value pairs $t=(a,v)$ if and only if

$$\varnothing \neq [T] = \bigcap_{t \in T} [t] \subseteq B.$$

Set T is a minimal complex of B if and only if B depends on T and no proper subset T' of T exists such that B depends on T'. Let T be a nonempty collection of nonempty sets of attribute-value pairs. Then T is a local covering of B if and only if the following conditions are satisfied:

1) each member T of T is a minimal complex of B,

2) $\bigcup_{T \in \mathbf{T}} [T] = B$, and

3) T is minimal, i.e., T has the smallest possible number of members.

Our experience with these methods shows that they are robust – they find informative features in data sets. They have been successfully used in applications (Fryc, 2013; Grzymala-Busse J. W. & Hippe Z. S., 2001).

Application of LEM2 algorithm for this research, is associated with the accurate record of the data. Therefore, the table-based data representation was selected that is characterized by two main features: universality (allows collecting and storing a variety of data sets) and efficiency (allows to easily computerized analysis of such stored data). The data were collected in the form of decision tables (Pawlak, 1982) i.e. tables of 2a type (consisting of any number of descriptive attributes (variables from general government sector) and only one dependent attribute (called decision from economy domain) located in the rightmost column. There were 224 decision tables for examining the impact of the general government sector on the economy prepared for each discretization interval respectively. For each decision table separate learning model as the decision rule set was generated. The learning models were tested using 10-fold-cross-validation. Ten-fold cross validation is commonly accepted as a standard way of validating classifiers. In this technique all cases are randomly reordered, and then a set of all cases is divided into ten mutually disjoint subsets of approximately equal size. For each subset all remaining cases are used for training a model, while the subset is used for testing. This approach allowed to obtain the best learning models in the form of rules and also allowed studying the importance of attributes used for the description of the general government sector. To build the models in the form of rules the RSES system (Skowron, 2005), with the default settings were used.

Conducted research proved that the best results of the classification are collected on the group of data with 4-section discretization. That is why, the model constructed basing on rules generated from this data, were taken for further and more precise analysis.

4. Results and Discussion

The first stage of research on an identification of compounds on line: size the general government sector – the economy, was to determine the answer to the question about the number of rules that indicate (in each examined year separately) the relationship between the size of the general government sector and the economy (identified by all the variables adopted to describe the size of the general government sector and all the variables applied to describe the economy). According to analyses results (see. Table 3), the number of rules indicating on the relationship between the size of the general government sector and the economy ranged from 131 rules (in 2005) to 173 rules (in 2010), and the whole of the analyzed period was closed with a number of 1 938 rules illustrating the correlation between the size of the sector and the economy.

The variables describing the size of the general government sector, which in the years 2000-13 (inclusive) were the most frequent in the rules indicating their relationship with the economy were: ratio called central government deficit (% GDP) – 1 359 occurrences in rules, ratio general government deficit (% GDP) – 1 162 occurrences in rules, and finally ration called government consolidated gross debt (% GDP) – 1 000 occurrences in rules indicating relationship between sector's size and economy. Next group of variables by the number of occurrences is: final consumption expenditure (% GDP) – 846 occurrences and public sector employment (number of people) – 752 occurrences. On the next positions, there would be variables as follows: net lending/ borrowing (million euro) – 627 occurrences in rules, general government gross capital formation (% GDP) – 607 occurrences in rules, and total general government revenue (euro per inhabitant) – 574 occurrences and finally ratio called total general government expenditure (euro per inhabitant) – 542 occurrences in rules indicating their relationship with the economy. There was also number of ratios that occurred less than 500 times: gross value added (general government total value-added) (basic (current) prices) – 473 occurrences, general government sector output (% GDP) – 466 occurrences and the ratio of total taxes to GDP (% GDP) – 439 occurrences. Decidedly less frequency of occurring in rules proving the relationship between size of the general government sector and the economy, was found in case of following ratios: general government gross fixed capital formation (% GDP), total general government expenditure (% GDP) and total general government revenue (% GDP). The first of them occurred in 395 rules,

second in barely 307 rules, and third in only 290 rules that identified the dependency mentioned above.

When we decide to transfer identified dependencies on the level of individual vintages, the analyzed the gap is even greater. In the group of variables describing the size of the general government sector, there was both these that in individual years had no relation to variables describing economy and those that occurred there very often. The variable describing the size of the general government sector, which in 2010-2013 (inclusive) did not appear in a single rule indicating its link with the economy, was the variable called public sector employment (number of people). On the other hand variable central government deficit (% GDP) occurred in 2010 in 151 rules indicating its relationship with the economy. In 2013 it was 143 rule, and in 2004 – 116 rules. Thus, the variable called central government deficit (% GDP) in the whole period occurred in nearly 3/4 of rules (i.e. 70.12%), demonstrating the relationship between the size of general government sector and the economy. For comparison purpose, the variables that was weakest in this ranking is the one called total general government revenue (% of GDP). It was found in less than 15% of rules (i.e. 14.96%), proving examined dependency and presenting less than 5 – fold effectiveness in explaining the relationship on the line: the size of the sector – the economy. For every rule that included variable called total general government revenue (% of GDP), in explaining the relationship between the size of the general government sector and the economy, there were 5 rules including the ratio called central government deficit (% GDP).

Conducted research showed that the variable on the side of the size of the general government sector, which in the whole examined period was characterized by the highest frequency of occurrences in the rules indicating the relationship between the size of the sector and the economy, was the rate called the central government deficit (% GDP). Thus, the mentioned measure by far the largest extent indicated a relationship identified in the study. Its presence in the rules defined for individual years and referred to total number o rules that in given year indicated a relationship between the variables describing the size of the sector and variables related to the economy, was ranged from 60% in 2005 (79 occurrences in total 131 rules from this year), to 87% in 2010 (151 occurrences in total 173 rules from this year) and in 2013 (143 occurrences in total 164 rules from this year).

When we reverse the analyzed relationship, i.e. when we identify the variables on the side of the size of general government sector, which in cross section of a single year, were characterized by the lowest percentage

of occurrences in the total number of rules that in a given year describing the relationship on the line: size of the general government sector – the economy, the situation looks much different. There was not a single variable in the entire analyzed set, which had the lowest frequency on occurrences in the rules in individual year. It was however possible to select a variable, which in the examined period had the most frequently decidedly lowest number of occurrences in rules. As agreed, the lowest frequency of occurrences in the rules describing the relationship between the size of the general government sector and the economy fluctuated in a range from 5% in 2012 to 18% in 2010 and 2013 and involved a variable called total general government revenue (% of GDP). Mentioned variable in 2012 occurred in only 8 out of 151 rules indicating the relationship between the size of the sector and the economy. In 2010 there were 31 occurrences of it in 173 rules (for the one year), and in 2013 this ratio had 30 occurrences in 164 rules, which were identified for the entire year 2013.

In the next stage of research, the authors tried to determine which of the variables describing the size of the general government sector as well as variables describing economy, showed a relationship with each other, and to present the sum of occurrences of given attribute of the general government sector in the rules that describe the economy in the years 2000-2013. The presentation of the obtained results is shown in Table 4. According to its content, statistics of occurrences of the attribute describing the size of general government sector in the rules describing economy in years 2000-2013, showed clearly its most frequent relation with the ratio called gross capital formation (% GDP). This relationship was shown in all variables describing sizes of the general government sector, except the ratio called gross value added (general government total value-added) (basic (current) prices. From the other side, the lees frequent relation of attributes presenting sizes of the general government sector was found in the rules describing economy in the years 2000-2013 and concerned the ratio called external balance of goods and services (million euro). In the case of 13 out of 15 variables describing sizes of general government sector (i.e. except general government gross fixed capital formation (% GDP) and public sector employment (number of people)), the smallest number of occurrences in the rules concerned the economic variable called external balance of goods and services (million euro). At the same time, the differences in the statistics of occurrences were really small. The variable called general government gross fixed capital formation (% GDP), occurred in the smallest number of rules with the economic variable called gross domestic product in current prices (per

inhabitant), and the ratio called public sector employment (number of people), occurred in the smallest number of rules with the variable called human development index – HDI (value from 0 to 1). However, as it was mentioned, the identified differences were small. The variable called general government gross fixed capital formation (% GDP), in relation to the economic ratio called external balance of goods and services (million euro) was found only once more in the rules than in its relation to the variable called gross domestic product in current prices (per inhabitant). From the other hand, the variable called public sector employment (number of people), in the relation to ratio called external balance of goods and services (million euro) had only two occurrences more than in the relation to variable human development index – HDI (value from 0 to 1). The parameter called gross capital formation (% GDP), was found as this economic variable that had the largest number of references in rules indicating relationship of sizes of the general government sector and the economy. From the other hand the economic variable that had the rarest number of occurrences in the rules proving the examined dependency was the parameter called external balance of goods and services (million Euros).

Table 5 presents expansion of Table 4. According to the research objective accepted in the article, it shows in how many years from the whole examined period, the authors identified a relationship between a single variable describing the size of the general government sector and a single variable presenting the economy, with the assumption that the ratio of the number of occurrences of a given attribute describing the size of the general government sector to the number of rules describing the economy in a given year was higher than 50%. According to Table 5, variables describing the size of the general government sector, which showed the most durable relationship with the variables describing the economy were the ones called central government deficit (% GDP) and the general government deficit (% GDP). The first one presented for 13 years (i.e. during the whole examined period), a relationship with variable called gross capital formation (% GDP) and variable unemployment rate (in %). The second confirmed the relationship with variable unemployment rate (in %) in the period of 12 years. The third ratio, in terms of stability of the relationships, was the parameter called government consolidated gross debt (% of GDP), and the fourth variable was the one called public sector employment (number of people). The ratio called consolidated gross government debt (% of GDP) (similar to the first two variables that was referred above), was in relation with a variable called unemployment rate

(in %), and the relationships was identified in the 10 out of the 13 examined years. On the other hand, the variable called public sector employment (number of people), was found in relationship with a called gross capital formation (% of GDP) in 9 years from the examined period.

Applying mentioned above criteria of 50% that assumed that ratio of number of occurrences of given sector's attribute to the number of rules describing the economy is greater than 50% in particular year – it was possible to determine the weakest measures of sector's size (understood as a measures in relation to which the number of years, when the relationship with economic variables was the smallest in the whole examined period 2000-13. According to this criterion, the weakest variables presenting sizes of the general government sector were two parameters: general government gross fixed capital formation (% GDP) and the ratio of total taxes to GDP (% GDP). The first of the mentioned variables did not fulfill the criteria of 50% in none of the examined years. That is why, it does not qualify to neither research nor explanation of analyzed dependency on the line: size of the general government sector – economy. From the other hand, the variable called the ratio of total taxes to GDP (% GDP), had proven the relationship with 4 variables on the economy's side (and these were: harmonized indices of consumer prices (HICPs) (annual average rate of change), as well as gross capital formation (% GDP) and the ratio called retail sales – dynamic (index of turnover – total 2010 = 100) and unemployment rate (in %)), but the this relationship was identified in only one year and did not repeat next years (so it had disposable character).

Using the accepted frequency of 50% of occurrences as the eligibility threshold of variables, the authors identified the widest and narrowest scale of relationships between variables belonging to the sector and variables that illustrate economy. Widest scale of relationships between variables describing the general government sector and the variables describing the economy, was characterized by two indicators. The first of them is central government deficit (% GDP), while second is general government deficit (% GDP). Both sector's variables was found in the rules with 18 (so all) variables that described economy. The next group of variables describing general government sector, which had very wide scale of relationships with the economic variables, were the following ratios: government consolidated gross debt (% GDP) and public sector employment (number of people). Mentioned variables showed a relationship with a 17 parameters describing the economy. The first of the appointed variables showed no relationship with only ratio: rate of FDI (foreign direct investment) (million USD). Second variable describing general

government sector stayed with no relation with the ratio called human development index – HDI (value from 0 to 1). The last, by the criteria of scale of the relationship with the economy, were three ratios describing general government sector: net lending/ borrowing (million euro), as well as ratio called final consumption expenditure (% GDP) and general government gross capital formation (% GDP). First from mentioned above, had no relationship with only two parameters describing economy, while remaining two stayed neutral towards four economic variables. The first variable was neutral towards following ratios: inward FDI flows (million USD) and outward FDI flows (million USD). The second one did not occur in the rules describing economy, in relation to following variables: gross domestic product in current prices (per inhabitant), human development index – HDI (value from 0 to 1), outward FDI flows (million USD) and gross domestic product in current prices (per inhabitant) – dynamic (percentage change). Finally, the variable called general government gross capital formation (% GDP), did not occur in the rules with following variables describing economy: external balance of goods and services (million euro), FDI (foreign direct investment) (million USD), as well as human development index – HDI (value from 0 to 1) and outward FDI flows (million USD).

5. Conclusion

Completed research allowed to build four rankings that evaluated examined aspects (in complementary to each other way) in relation to the line: the size of the general government sector – the economy. Presented rankings were used as a basis for the development of classification that presents in combined way the ranking position of variables describing the size of the general government sector on the basis of each of the four criteria (corresponding to the four autonomous rankings). On this basis, the average position ranking for each variable describing the sector was determined. In the next step, the authors listed the variables describing the size of the general government sector according to the criterion of the average ranking position occupied by variable. It was assumed that the higher the rank variable was the better it was to explain the dependence occurring between the size of the general government sector and the economy.

The first ranking concerned the variables describing the size of the general government sector according to the criterion of the maximum number of occurrences in the rules describing the economy (see. Table 6).

According to its content, variables determining the size of the general government sector, which occurred most frequently in the rules to explain the relationship between the size of the sector and the economy were the ones called: central government deficit (% GDP) as well as general government deficit (% GDP) and government consolidated gross debt (% GDP). First of them occurred in 1 359 rules, second in 1 162 rules, and third was identified in 1000 rules. The variables describing the sizes of general government sector, which were characterized by the smallest number of occurrences in rules describing relationship with the economy were: total general government expenditure (% GDP) – 307 occurrences and the ratio called total general government revenue (% GDP) – 290 occurrences.

Second from the rankings presents the number of relationships identified in relation to single variable describing the sizes of general government sector with a single variable describing the economy (see. Table 7). The largest number of variables describing the economy were: central government deficit (% GDP) – 151 occurrences. Next places were taken by following ratios: general government deficit (% GDP) – 132 occurrences and government consolidated gross debt (% GDP) – 115 occurrences. Decidedly weakest result was achieved by the ratio called total general government revenue (% GDP), in relations to which in whole examined period, where 38 occurrences in rules explaining relationship of the size of general government sector with the economy was found. This the reason, why the ranking by the number of relationships identified in relation to single variable describing the size of the general government sector with a variable describing the economy, duplicated classification of variables that was prepared based on the first of the presented criteria.

A third of the rankings allowed determining which of the variables describing the size of the general government sector and the variables describing the economy in examined period showed the highest frequency of compounds measured by the number of years which identified links between variables (see. Table 8). According to achieved results, the ratio called central government deficit (% GDP) describing sizes of general government sector had decidedly highest frequency in relation with variables called gross capital formation (% GDP) and unemployment rate (in %) describing economy. In both cases, this relationship was maintained in whole examined period 2000-2013 (inclusive). Relationship between the variable called unemployment rate (in %) describing economy, was also identified in case of following variables: general government deficit (% GDP) and government consolidated gross debt (% GDP). The

mentioned relationship was found in respectively 12 and 10 years of examination. The remaining, the most frequently appearing in the rules variables, which describe the sizes of general government sector was in correspondence with others(than mentioned above) variables that describe economy. In the case of the variable called public sector employment (number of people) the topical variable was the one called gross capital formation (% GDP), and the relationship that described them was noticed in 9 years from the examined period. Next variable in the classification, i.e ratio called net lending/ borrowing (million euro), was in correspondence of the economic variable called human development index – HDI (value from 0 to 1), and the relation was found in 7 out of 13 examined years. From the other hand, the indicator final consumption expenditure (% GDP), corresponded with the variable called gross capital formation (% GDP), and this dependency was found in 6 years from the period being researched. Next sector's variable, i.e. variable called total general government revenue (euro per inhabitant), was found in the relationship with two economic variables in examined period. First of them was the variable called gross domestic product in current prices (per inhabitant), while second was the variable called gross domestic product in current prices (per inhabitant) – dynamic (percentage change). In relation to both of them, the relationship of sector to economy was identified in the period of 5 years. The relationship of variables general government gross capital formation (% GDP) and retail sales – dynamic (index of turnover – total 2010 = 100) was identified in the period of 3 years. In 2 out of 13 analyzed years, the authors identified dependency in relation in decidedly highest number of ratios of sector sizes and the economy. The variable called gross value added (general government total value-added) (basic (current) prices) corresponded with the economy production in industry – dynamic (percentage change compared to same period in previous year). The indicator called general government sector output (% GDP) was in relationship with the variable called gross capital formation (% GDP). Sector's variable called total general government expenditure (% GDP) presented relationship with the variable called human development index – HDI (value from 0 to 1), and parameter called total general government revenue (% GDP) corresponded with the variable called human development index – HDI (value from 0 to 1). In separate case of the variable total general government expenditure (euro per inhabitant) describing sizes of general government sector, the authors identified relationship with two economic variables, and these were: gross domestic product in current prices (per inhabitant) and parameter called gross

domestic product in current prices (per inhabitant) – dynamic (percentage change). As it was mentioned above, in all identified pairs of variables, the dependency was found in only 2 out of 13 investigated years. The weakest variable in this ranking was: the ratio of total taxes to GDP (% GDP), in relations to which it was relationship with 4 variables(and these were: harmonized indices of consumer prices (HICPs) (annual average rate of change), and next in the order gross capital formation (% GDP), as well as retail sales – dynamic (index of turnover – total 2010 = 100) and unemployment rate (in %)), although in relation to all of them the identified relationship occurred only in 1 year from the examined period 2000-2013.

Fourth of the rankings is presented basing on the criteria of number of occurrences of variables that describe the sizes of general government sector in relation to single economic variable (see. Table 9). This ranking was produced with the assumption that the relation of number of occurrences on given attribute presenting sizes of general government sector to the number of rules describing economy in given year was greater than 50 %. According to selected criteria, the variables describing sizes of general government sector, which had relationship with all 18 variables describing economy, were: central government deficit (% GDP) and general government deficit (% GDP). The similarly high result was found in the relationship of two other variables describing sector's size, i.e. government consolidated gross debt (% GDP) and public sector employment (number of people). In relation to all of them, there were relationships with 17 variables describing economy of examined EU Member States. Slightly weaker result was identified in the case of the variable called net lending / borrowing (million euro), which was found in relationship of 16 out of 18 economic variables. Although, the worst variables in this ranking were: general government sector output (% GDP), total general government expenditure (% GDP) and total general government revenue (% GDP). First two variables had relationship with 3 out of 18 economic variables, and the last sector's variable had relationship with only two economic variables[2].

[2] The result equals „0" for the variable describing sizes of general government sector, which is the one called general government gross fixed capital formation (% GDP), is taken from the situation, where the variable does not fulfill approved criteria of 50%, what means that the relations of number of occurrences of this attribute presenting sizes of general government sector to number of rules describing economy was smaller than 50% in all of the examined years(see. Table 9).

Presented above rankings of sector's variables described in tables 6, 7, 8 and 9, were used to create combined ranking of variables describing sizes of general government sector, produced in order to identify the usability of particular sector's variables to explain the dependency on the line: general government sector – economy. The fundament for construction of this ranking was the average ranking position each of the variables describing the size of general government sector, calculated as the average arithmetic position from all four rankings. In this way, the variables describing sizes general government sector were listed by the criteria of average ranking position taken by given variable. For a classification built this way, the authors assumed that the higher the rank of the variable describing the size of the general government sectors, the better it qualifies to explain the relationship between the size of the sector and the economy (see. Table 10). In accordance with a prepared ranking, four top places were taken respectively by following variables: first place – central government deficit (% GDP), second place the variable called general government deficit (% GDP), third place – the ratio government consolidated gross debt (% GDP), and fourth place – variable called public sector employment (number of people). Fifth place was taken *ex aequo* by two variables: final consumption expenditure (% GDP) and net lending/ borrowing (million euro), whereas sixth place was taken by indicator the called general government gross capital formation (% GDP). Seventh place in the ranking of sector's variable were taken by three indicators: total general government revenue (euro per inhabitant), an in the next place the variable total general government expenditure (euro per inhabitant) and gross value added (general government total value-added) (basic (current) prices). Eighth and ninth place was *ex aequo* taken by two variables. Place number eight was taken by the variables: the ratio of total taxes to GDP (% GDP) and general government sector output (% GDP). Although on the place number nine there were ranked variables: general government gross fixed capital formation (% GDP) and total general government expenditure (% GDP). The last, tenth place was taken by the variable called total general government revenue (% GDP), what proved its usability in relation between the size of general government sector and the economy.

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Table 3.

Total number of rules indicating in each individual year on relations of size general government sector and the economy (identified with all variables expressing size of general government sector and all variables describing economy).

Attribute describing size of general government sector	**2000**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2000-13**
Central government deficit (% GDP)	98	97	109	116	79	84	88	97	88	151	100	109	143	**1359**
General government deficit (% GDP)	92	97	95	95	79	58	73	75	69	132	82	89	126	**1162**
Government consolidated gross debt (% GDP)	71	76	82	85	54	66	64	75	68	93	74	77	115	**1000**
Final consumption expenditure (% GDP)	52	57	63	71	55	48	50	61	49	93	73	68	106	**846**
General Government gross capital formation (% GDP)	30	36	66	60	32	29	50	50	44	69	41	27	73	**607**
General government gross fixed capital formation (% GDP)	13	22	57	41	18	23	26	32	17	44	34	21	47	**395**
Gross value added (General Government total value-added) (Basic (current) prices)	38	24	36	25	30	28	27	42	38	64	36	28	57	**473**
General Government Sector Output (% GDP)	40	27	45	35	29	35	31	39	41	43	24	32	45	**466**
Public sector employment (Number of people)	76	82	99	94	71	70	84	89	87	0	0	0	0	**752**
The ratio of total taxes to GDP (% GDP)	31	40	38	44	29	42	30	40	25	49	39	32	0	**439**
Total General Government Expenditure (% GDP)	16	19	26	27	23	20	13	24	17	48	23	16	35	**307**
Total General Government Expenditure (Euro per inhabitant)	33	43	41	49	34	40	41	42	31	45	49	37	57	**542**
Total General Government Revenue (% GDP)	22	26	21	38	29	20	12	16	20	31	17	8	30	**290**
Total General Government Revenue (Euro per inhabitant)	40	44	35	48	45	43	51	47	39	51	39	45	47	**574**
Net lending/ borrowing (Million Euro)	52	55	46	48	35	21	28	20	33	98	39	55	97	**627**
Total number of rules	**135**	**149**	**162**	**165**	**131**	**135**	**136**	**150**	**139**	**173**	**148**	**151**	**164**	**1938**

Source: Own work.

Table 4.

Ranking presenting relation of variables describing size of general government sector with individual variables describing economy in examined period of years 2000-2013 (number in brackets is the sum of occurrences of particular attribute of general government sector in rules describing economy in the years 2000-2013).

	External balance of goods and services (Million euro)	**Gross Domestic Product in current prices (per inhabitant)**	**Production in industry – dynamic (Percentage change compared to same period in previous year)**	**Balance of the current account (Million euro)**	**Potential output of total economy (Million euro)**	**Harmonized Indices of Consumer Prices (HICPs) (Annual average rate of change)**	**Inward FDI flows (Million USD)**	**FDI (Foreign direct investment) (Million USD)**	**Real effective exchange rate (Index 1999 = 100)**	**Human Development Index – HDI (Value from 0 to 1)**	**Outward FDI flows (Million USD)**	**Growth rates of GDP (Percentage change)**	**Gross capital formation (% GDP)**	**Gross Domestic Product in current prices (per inhabitant) - dynamic (Percentage change)**	**Activity rate (in %)**	**Retail sales - dynamic (Index of turnover – Total 2010 = 100)**	**Potential output of total economy - dynamic (Annual average rate of growth - percentage)**	**Unemployment rate (in %)**
Central government deficit (% GDP)	23	36	105	69	116	72	45	44	56	63	47	99	138	98	66	95	71	116
General government deficit (% GDP)	21	29	101	60	103	58	34	34	50	59	37	88	107	83	54	83	56	105

Government consolidated gross debt (% GDP)	18	26	77	39	101	52	33	26	35	48	28	71	104	82	41	67	62	90
Final consumption expenditure (% GDP)	10	12	67	36	73	41	30	18	40	53	20	60	89	67	53	56	51	70
General Government gross capital formation (% GDP)	8	10	48	26	57	36	21	12	26	26	16	50	63	50	33	49	30	46
General government gross fixed capital formation (% GDP)	5	4	36	20	40	26	13	9	14	18	11	32	44	32	23	24	20	24
Gross value added (General Government total value-added) (Basic (current) prices)	1	5	50	21	44	28	11	8	23	27	16	30	49	38	27	35	24	36
General Government Sector Output (% GDP)	4	4	37	22	35	27	11	10	26	24	15	28	56	38	27	39	26	37
Public sector employment (Number of people)	18	19	62	35	68	43	28	26	30	16	29	60	69	55	40	54	34	66
The ratio of total taxes to GDP (% GDP)	2	8	36	26	35	30	8	10	15	22	10	37	47	38	15	31	26	43
Total General Government Expenditure (% GDP)	1	1	21	16	17	17	10	6	10	18	8	28	41	38	12	19	20	24
Total General Government Expenditure (Euro per inhabitant)	5	21	41	23	31	31	23	9	24	38	15	39	54	42	46	30	31	39
Total General Government Revenue (% GDP)	3	3	17	12	12	17	9	8	9	12	3	37	41	33	14	22	12	26
Total General Government Revenue (Euro per inhabitant)	16	27	39	19	31	29	24	19	23	43	20	44	54	46	45	32	26	37
Net lending/ borrowing (Million Euro)	11	17	51	33	59	38	14	15	26	33	11	48	69	49	27	38	30	58

Source: Own work.

Table 5. Ranking presenting relation of variables describing sizes of general government sector with particular variables describing economy in examined period of the years 2000-2013 (the number in brackets informs about the number of years in examined period, where ratio of number of occurrences of given attribute presenting the size of general government sector to number of rules describing economy in given was larger than 50%).

	External balance of goods and services (Million euro)	**Gross Domestic Product in current prices (per inhabitant)**	**Production in industry – dynamic (Percentage change compared to same period in previous year)**	**Balance of the current account (Million euro)**	**Potential output of total economy (Million euro)**	**Harmonized Indices of Consumer Prices (HICPs) (Annual average rate of change)**	**Inward FDI flows (Million USD)**	**FDI (Foreign direct investment) (Million USD)**	**Real effective exchange rate (Index 1999 = 100)**	**Human Development Index – HDI (Value from 0 to 1)**	**Outward FDI flows (Million USD)**	**Growth rates of GDP (Percentage change)**	**Gross capital formation (% GDP)**	**Gross Domestic Product in current prices (per inhabitant) - dynamic (Percentage change)**	**Activity rate (in %)**	**Retail sales - dynamic (Index of turnover – Total 2010 = 100)**	**Potential output of total economy - dynamic (Annual average rate of growth - percentage)**	**Unemployment rate (in %)**
Central government deficit (% GDP)	6	6	11	10	10	10	7	8	9	5	7	10	13	6	10	12	9	13
General government deficit (% GDP)	4	4	10	5	5	8	2	5	5	4	6	5	10	4	5	8	5	12
Government consolidated gross debt (% GDP)	3	3	5	2	2	5	3	0	5	4	2	2	9	3	2	4	7	10
Final consumption expenditure (% GDP)	1	0	4	1	1	1	2	1	4	0	0	1	6	0	1	2	3	5

General Government gross capital formation (% GDP)	0	1	1	1	1	1	1	0	1	0	0	1	2	1	1	3	1	1
General government gross fixed capital formation (% GDP)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross value added (General Government total value-added) (Basic (current) prices)	0	0	2	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0
General Government Sector Output (% GDP)	0	0	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0
Public sector employment (Number of people)	3	2	8	3	3	8	2	2	3	0	4	3	9	2	3	5	3	7
The ratio of total taxes to GDP (% GDP)	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1
Total General Government Expenditure (% GDP)	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1
Total General Govern-ment Expenditure (Euro per inhabitant)	0	2	1	0	0	0	1	0	1	0	0	0	1	2	0	0	0	0
Total General Government Revenue (% GDP)	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0
Total General Government Revenue (Euro per inhabitant)	2	5	0	0	0	1	1	0	0	1	0	0	0	5	0	0	0	0
Net lending/ borrowing (Million Euro)	1	1	2	3	3	2	0	1	2	7	0	3	4	1	3	2	2	2

Source: Own work.

Table 6.

Ranking by the maximum number of occurrences of a variable describing the size of the general government sector in the rules describing economy in the period 2000-2013 (inclusive).

No	Name of variable	Value
1	Central government deficit (% GDP)	1359
2	General government deficit (% GDP)	1162
3	Government consolidated gross debt (% GDP)	1000
4	Final consumption expenditure (% GDP)	846
5	Public sector employment (Number of people)	752
6	Net lending/ borrowing (Million Euro)	627
7	General Government gross capital formation (% GDP)	607
8	Total General Government Revenue (Euro per inhabitant)	574
9	Total General Government Expenditure (Euro per inhabitant)	542
10	Gross value added (General Government total value-added) (Basic (current) prices)	473
11	General Government Sector Output (% GDP)	466
12	The ratio of total taxes to GDP (% GDP)	439
13	General government gross fixed capital formation (% GDP)	395
14	Total General Government Expenditure (% GDP)	307
15	Total General Government Revenue (% GDP)	290

Source: Own work.

Table 7.
Ranking by number of relations identified in a reference to single variable describing the size of the general government sector with a variable describing the economy in the period 2000-2013 (inclusive).

No	Name of variable	Value
1	Central government deficit (% GDP)	151
2	General government deficit (% GDP)	132
3	Government consolidated gross debt (% GDP)	115
4	Final consumption expenditure (% GDP)	106
5	Public sector employment (Number of people)	99
6	Net lending/ borrowing (Million Euro)	98
7	General Government gross capital formation (% GDP)	73
8	Gross value added (General Government total value-added) (Basic (current) prices)	64
9	General government gross fixed capital formation (% GDP)	57
10	Total General Government Expenditure (Euro per inhabitant)	57
11	Total General Government Revenue (Euro per inhabitant)	51
12	The ratio of total taxes to GDP (% GDP)	49
13	Total General Government Expenditure (% GDP)	48
14	General Government Sector Output (% GDP)	45
15	Total General Government Revenue (% GDP)	38

Source: Own work.

Table 8.

Ranking by the number of years in which authors observed a relationship between a variable describing the size of the general government sector and a variable describing the economy in the period 2000 to 2013 (inclusive).

No	Name of variable describing size of general government sector	Name of variable describing economy	Number of years, when relationship between size of general government sector and economy was identified*
1	Central government deficit (% GDP)	Gross capital formation (% GDP)	13
		Unemployment rate (in %)	13
2	General government deficit (% GDP)	Unemployment rate (in %)	12
3	Government consolidated gross debt (% GDP)	Unemployment rate (in %)	10
4	Public sector employment (Number of people)	Gross capital formation (% GDP)	9
5	Net lending/ borrowing (Million Euro)	Human Development Index – HDI (Value from 0 to 1)	7
6	Final consumption expenditure (% GDP)	Gross capital formation (% GDP)	6
7	Total General Government Revenue (Euro per inhabitant)	Gross Domestic Product in current prices (per inhabitant)	5
		Gross Domestic Product in current prices (per inhabitant) - dynamic (Percentage change)	5
8	General Government gross capital formation (% GDP)	Retail sales - dynamic (Index of turnover – Total 2010 = 100)	3
9	Gross value added (General Government total value-added) (Basic (current) prices)	Production in industry – dynamic (Percentage change compared to same period in previous year)	2
	General Government Sector Output (% GDP)	Gross capital formation (% GDP)	2
	Total General Government Expenditure (% GDP)	Human Development Index – HDI (Value from 0 to 1)	2
	Total General Government Expenditure (Euro per inhabitant)	Gross Domestic Product in current prices (per inhabitant)	2

		Gross Domestic Product in current prices (per inhabitant) - dynamic (Percentage change)	2
	Total General Government Revenue (% GDP)	Human Development Index – HDI (Value from 0 to 1)	2
10	The ratio of total taxes to GDP (% GDP)	Harmonized Indices of Consumer Prices (HICPs) (Annual average rate of change)	1
		Gross capital formation (% GDP)	1
		Retail sales – dynamic (Index of turnover – Total 2010 = 100)	1
		Unemployment rate (in %)	1
11	General government gross fixed capital formation (% GDP)	No relation with economic variables	0

* Ranking has been developed with the assumption that the ratio of the number of occurrences of a given attribute presenting the size of the general government sector to the number of rules describing the economy in a given year was higher than 50%.

Source: Own work.

Table 9.
Ranking by the number of occurrences of the variable describing the size of the general government sector in the rules describing the relationship with the economy in the period 2000 to 2013 (inclusive).

No	Name of variable	Number of occurrences (Number of variables describing economy = 18)*
1	Central government deficit (% GDP)	18
1	General government deficit (% GDP)	18
2	Government consolidated gross debt (% GDP)	17
2	Public sector employment (Number of people)	17
3	Net lending/ borrowing (Million Euro)	16
4	Final consumption expenditure (% GDP)	14
4	General Government gross capital formation (% GDP)	14
5	Total General Government Expenditure (Euro per inhabitant)	6
5	Total General Government Revenue (Euro per inhabitant)	6
6	Gross value added (General Government total value-added) (Basic (current) prices)	5
7	The ratio of total taxes to GDP (% GDP)	4
8	General Government Sector Output (% GDP)	3
8	Total General Government Expenditure (% GDP)	3
9	Total General Government Revenue (% GDP)	2
10	General government gross fixed capital formation (% GDP)	0

* Ranking has been developed with the assumption that the ratio of the number of occurrences of a given attribute presenting the size of the general government sector to the number of rules describing the economy in a given year was higher than 50%.

Source: Own work.

Table 10.
Classification of variables describing the size of the general government sector presenting the "strongest" relationship with the variables describing the economy according to the criterion of the average position ranking achieved by a given variable in the individual rankings

Name of variable describing sizes of general government sector	Ranking 1	Ranking 2	Ranking 3	Ranking 4	Average ranking position of variable	Variable describing size of general government sector showing the most common relation with economy*
Central government deficit (% GDP)	1	1	1	1	1	1
General government deficit (% GDP)	2	2	2	1	2	2
Government consolidated gross debt (% GDP)	3	3	3	2	3	3
Public sector employment (Number of people)	5	5	4	2	4	4
Final consumption expenditure (% GDP)	4	4	6	4	5	5
Net lending/ borrowing (Million Euro)	6	6	5	3	5	5
General Government gross capital formation (% GDP)	7	7	8	4	7	6
Total General Government Revenue (Euro per inhabitant)	8	10	7	5	8	7
Total General Government Expenditure (Euro per inhabitant)	9	9	9	5	8	7
Gross value added (General Government total value-added) (Basic (current) prices)	10	8	9	6	8	7
The ratio of total taxes to GDP (% GDP)	12	11	10	7	10	8

General Government Sector Output (% GDP)	11	13	9	8	10	8
General government gross fixed capital formation (% GDP)	13	9	11	10	11	9
Total General Government Expenditure (% GDP)	14	12	9	8	11	9
Total General Government Revenue (% GDP)	15	14	9	9	12	10

* Ranking has been developed with the assumption that the ratio of the number of occurrences of a given attribute presenting the size of the general government sector to the number of rules describing the economy in a given year was higher than 50%.

Ranking 1. Ranking by the maximum number of occurrences of a variable describing the size of the general government sector in the rules describing economy in the period 2000-2013 (inclusive)

Ranking 2. Ranking by number of relations identified in a reference to single variable describing the size of the general government sector with a variable describing the economy in the period 2000-2013 (inclusive)

Ranking 3. Ranking by the number of years in which authors observed a relationship between a variable describing the size of the general government sector and a variable describing the economy in the period 2000 to 2013 (inclusive)

Ranking 4. Ranking by the number of occurrences of the variable describing the size of the general government sector in the rules describing the relationship with the economy in the period 2000 to 2013 (inclusive)

Source: Own work.

FACTORS AFFECTING THE EFFECTIVENESS OF INTERNAL AUDITS OF QUALITY MANAGEMENT SYSTEM

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Abstract. *The paper presents a dissertation concerning the effectiveness of internal audits performed in the area of systems of quality management ISO 9001. On the basis of interview with the management representative of the Municipal Office in Dzierżoniów – organization which is recognized as the leader in the area of quality management in Poland – it determined eight factors which directly influence the effectiveness of internal audits most significantly.*

The most significant factor influencing the effectiveness of internal audits was considered involving auditors in other (besides the audits) activities concerning quality management. The second most important issue was having a proper number of active auditors. It is worth mentioning that ISO 9001 does not formulate requirements directly concerning neither of the issues.

Keywords*: internal audit, effectiveness, quality management system, ISO 9001.*

1. Introduction

Since the publication of the ISO 9000 series of standards in 1987, they have been used by many companies and organizations as an important milestone to mark their quality journeys. (Lee, Leung, Chan, 1999, p. 88). The ISO 9001 defines requirements for quality management systems (QMS). The standard does not refer to the compliance with an objective or with a particular result which means it is not a performance standard measuring the quality of companies' products or services. However, ISO 9001 proposes guidelines to systematize and formalize a series of company processes into a series of procedures, and to document the implementation. ISO 9001 standardizes procedures, duties and roles, rather than goals or outcomes (Heras-Saizarbitoria, Boiral, 2013, p. 2013). If quality management system is implemented correctly, as opposed to being used

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merely as a marketing and promotional tool, there are significant internal and external benefits to be derived by any organization that adopts the standard. However, the introduction of a QMS in an organization does not always produce the desired results; in practice, this is usually due to an ineffective implementation (Psomas, Fotopoulos, Kafetzopoulos, 2010, p. 441)

Quality management system may be seen as a set of joined solutions such as: researching the customers' needs and satisfaction, control of the records, management reviews, internal audits, corrective and preventive actions, etc (Chin, Poon, Pun, 2000). The effectiveness of each of the elements directly influences the effectiveness of the whole quality management system. In professional studies there are a lot of articles concerning the effectiveness of the QMS seen as a whole. However, it lacks studies concerning its separate elements e.g. internal audits. Few articles present the practice of the activity (e.g. analysing problems that internal auditors meet), diagnosis of the reasons for their occurrence or a suggestion how to deal with them. The paper should contribute to filling these voids. The main aim of the study is to rank the factors influencing the efficiency of the internal audits. The study will be prepared basing on the opinions of the management representative from the Municipal Office in Dzierżoniów – organization which is recognized as the leader in the area of quality management in Poland.

2. Background and related researches

The ISO 9001 standard requires organization to conduct internal audits at planned intervals to determine whether the quality management system conforms to the planned arrangements and to the requirements of ISO 9001. (PN-EN ISO 9001, 2010, p. 34). Internal auditing is widely recognized as an important business tool in the area of quality management (Bhatti, Awan, 2004, p. 21). First of all it is accepted as a driver for compliance to ISO 9001:2008 standards (Hernandez 2010, pp. 454-466) it may, however, contribute to achieving other benefits. For example Alić and Rusjan proved that internal audits can:

1) stimulate workers to work better (following the procedures and rules, more effective and more efficient work),
2) represent a means to exchange knowledge and spread good practices,
3) represent a means to stimulate business improvements,

4) help managers attain the business objectives of the company (Alić, Rusjan, 2011, 284-300).

Additionally, internal audits may cause: the reduction of risk, realization of synergies, less duplication and overlap of efforts (including: training, paperwork, administration) and enhanced corporate image-external recognition of management capabilities (Kaziliûnas, 2008, p. 67).

To achieve the benefits, audits should be properly planned and performed. It is assumed that an effective audit:

1) has adequately defined audit objectives, approved by all stakeholders;
2) has a suitable plan accepted by all;
3) allows for adequate resources; people and time;
4) is executed by competent auditors;
5) is conducted in accordance with a standard or procedure;
6) has findings that are valid and significant to record which are analyzed against objectives and risk and that lead to improvements;
7) has satisfied clients; and
8) provides evidence of improved working practices (Elliott, Dawson, Edwards, 2007, p. 555).

Although in the professional literature there are articles describing organizations which have successfully implemented a system of internal audits (Kettunen, 2012), they are very scare. The opinion that potential benefits of the internal audits are rarely achieved in practice is much more popular (Nichols, 2012). It is stressed among others that audits too strongly focus on checking if the documented rules and procedures are being respected. This audit method does not include any judgment regarding the adequacy of the rules and their ability to make it possible to reach organizational goals (Biazzo, 2005, p. 385). It is also noticed that the internal auditors' skills are too low and they have a limited knowledge of the areas they audit. Therefore an auditor, who is not an expert for a certain area, cannot audit this area (Pivka, 2004, p. 350).

3. Quality management in Municipal Office in Dzierżoniów

For many years the Municipal Office (MO) in Dzierżoniów has consequently utilized various solutions in the area of quality management. Over 15 years ago Municipal Office in Dzierżoniów decided to implement a quality management system. As a result in 1999, the Municipal Office in

Dzierżoniów, as the first Polish office of public administration, was certified to meet the requirements of ISO 9002 standard. Three years later the QMS underwent successive certification to meet the requirements of ISO 9001 standard. The following years started a process of implementing next management systems i.e. the environmental management system ISO 14001 and occupational health and safety management system PN 18001. They were being integrated into QMS even at the implementation level. The Municipal Office's efforts were awarded in 2006 with a certificate of integrated management system. It was recertified in 2010. Additionally, in 2013 the office underwent a procedure certifying compliance with the requirements of ISO 5001 standard. As a result it was demonstrated that the organization implemented a system of energy management which increases the energy efficiency, lowers the costs, and reduces the organizational risk.

Since 2003 the Municipal Office in Dzierżoniów has utilized the EFQM Excellence Model to perform self-assessments. The results have been used to point out the strengths of an organization and identify areas which need correction. On 9th October the mayor of Dzierżoniów was awarded with a statue of the finalist of the contest organized by EFQM. This meant that MO in Dzierżoniów became the first – and as far the only one – Polish office to receive the distinction.

Except formalized systems and the EFQM Excellence Model, the Municipal Office in Dzierżoniów, applies several other solutions in the area of quality management. The use of the Prince 2 method concerning project management, introducing a system approach in teamwork, using a Balanced Score Card and also applying the DMAIC model in improving the organization may serve as examples.

The approach to management applied by the office gained recognition of many specialist branches. It is reflected in a number of awards and distinctions the office has received. For example: in 2014 Dzierżoniów received the title of "the best Polish local authority of the decade". The event rose interest of many organizations in Poland and abroad wishing to learn the solutions used in Municipal Office in Dzierżoniów. The key activities in the area concerned:

1) hosting the representatives of such organizations. In the past few years the office was visited by delegations of e.g. Ricoh and Volkswagen Motor Poland,
2) cooperation with EFQM in e.g. consulting changes in the Excellence Model,

3) active participation in experience exchange groups among other districts in the area of project accomplished by the Association of Polish Cities,
4) accomplishment of the mentioned project ”The improvement program of public services quality in the offices of Lower Silesia and Lesser Poland with the use of Dzierżoniów Municipal Office’s experience” which involved 27 offices improving their functioning using experiences and solutions of the Municipal Office in Dzierżoniów,
5) thanks to these achievements the Municipal Office in Dzierżoniów is recognized as the leader in the area of quality management.

4. The ranking of the factors influencing the efficiency of internal audits

The study consisted of two stages. The first one identified the factors influencing the effectiveness of internal audits. In the second stage the management representative of the MO in Dzierżoniów evaluated the significance of each of them. The research was limited to one office only as the aim of the study was to find out about the opinion of the leading organization to establish a benchmark for other organizations. If the survey had been sent to more organizations it would have provided information both: from organizations with a mature system of quality management and those with an inappropriately implemented QMS.

The list of the factors which may influence the effectiveness of the internal audits was prepared on the analysis of the content of ISO 9001 and specialist literature. It showed that there are two types of the factors. The first group consists of the issues which are directly influenced by the management representative. One of the factors in the group is for example the number of internal audits carried out every year. The second group are the factors without a direct influence of the management representative. In the group there are e.g.: awareness and commitment of the top management and also the auditors’ responsibility. It was decided that the task would concentrate on the first group of factors. The research identified 16 issues of the kind:

1) a set and documented method of appointing new auditors,

2) proper number of the auditors in a board,
3) cyclical and sufficiently frequent trainings of the auditors carried out by external coaches,
4) cyclical and sufficiently frequent trainings of the auditors carried out by the employees of the organization,
5) consistency in following the schedules of internal audits (promptness of the audits),
6) precise description of the method of carrying out the audits (a detailed procedure of internal audits),
7) appropriate number of audits every year,
8) appropriate length of every audit,
9) covering all significant aspects of the organization's functioning with audits in a yearly cycle,
10) involving auditors in co-planning the corrective actions or other improvement activities performed on the basis of the audits,
11) financial rewards for the auditors work,
12) cyclical improvement of the audits procedure,
13) involving auditors in other (besides the audits) activities concerning quality management,
14) appropriately precise and extensive method of reporting the results of the audits,
15) proper selection of the auditors for every audit (e.g. preventing biased auditors because of their relations with the audited organizations),
16) proper methods of verifying the effectiveness of the audits.

The set of 16 factors was given to the management representative from MO in Dzierżoniów. He was asked to distribute 100 points among them judging their influence on the effectiveness of internal audits. It was also accepted that giving a factor 0 points does not mean it is totally insignificant. Receiving 0 points may mean that the significance of the issue is much lower than those which received any points. It served to identify seven key factors influencing the effectiveness of internal audits (table 1).

Table 1

Factors influencing the effectiveness of internal audits

No.	Factor	Grade
1.	Involving auditors in other (besides the audits) activities concerning quality management	30
2.	Proper number of active auditors	20
3.	Cyclical and sufficiently frequent trainings of the auditors carried out by external coaches	10
4.	Cyclical and sufficiently frequent trainings of the auditors carried out by the employees of the organization	10
5.	Precise description of the method of carrying out the audits (a detailed procedure of internal audits)	10
6.	Covering all significant aspects of the organization's functioning with audits in a yearly cycle	10
7.	Proper methods of verifying the effectiveness of the audits	10

Source: own elaboration.

The most significant factor influencing the effectiveness of internal audits was considered involving auditors in other (besides the audits) activities concerning quality management. The second most important issue was having a proper number of active auditors. It is worth mentioning that ISO 9001 does not formulate requirements directly concerning neither of the issues. The remaining 5 factors were evaluated as equally significant from the point of view of internal audits' effectiveness.

Moreover, the respondents pointed out the significance of one factor which had not been included in the survey. In her opinion the series of audits should always be carried out in one period (e.g. always in March and October). This procedure would let the results be analysed together which facilitates planning and taking successful improvement actions.

5. Conclusion

The paper identifies eight determinants which according to the Municipal Office in Dzierżoniów, leader in the area of quality management, may be considered as the most important for the effectiveness of internal audits. The information may be widely used in practice. They can serve the management representatives of many organizations to improve their own programmes of internal audits which subsequently should contribute to improving the effectiveness of systems of quality management.

The limitations of the carried out research should not be forgotten. First of all, they concern the fact that the conclusions were drawn on the basis of the experience of only one organization. A similar future research should cover other organizations and its results ought to be confronted with the conclusions presented in this article. However, it should be remembered that the research must be carried out only among organizations, which are the leaders in the area of quality management.

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MANAGERIAL PREFERENCES BETWEEN ACCRUAL-BASED VERSUS REAL EARNINGS MANAGEMENT

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Abstract. *There is substantial evidence that managers engage in accounting earnings management. An emerging stream of research investigates the tradeoffs and managerial preferences between real earnings management and accrual-based earnings management. In this respect, existing empirical evidence suggests that both types can be substituted for each other in order to manage earnings. However, the research also indicates that the two methods can be used in tandem to achieve a desired outcome. Given that both types be used to achieve accounting outcomes, each form of earnings management may be relevant to be assessed by the users of accounting information. The goal of this paper is to discuss their implications in financial reporting while attempts to fill that void in the earnings management literature in an effort to advance our understanding of managers' financial reporting behavior.*

Keywords: *accrual based earnings management, real earnings management, trade off effect, manipulative behavior.*

JEL Codes: M40, M41

1. Introduction

Earnings management practices are extensively approached in contemporary research, being considered one of the most significant discussions in accounting arena so far. This paper is part of such trend, analyzing one of the most recent trends of research from this area (i.e. the trade-off between accrual-based versus real earnings management). By revisiting prior results documented in the literature we were able to summarize the most recent publishing trends and to interpret such evidence. While accrual based earnings management was extensively assessed in the literature in previous years (Dechow et al., 2011, 2012), real earnings management comprised a changing balance in the recent period in the detriment of the first category.

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Our subject is timely and relevant at least for three reasons. First, in the light of the previous accounting scandals, earnings management practices became of highly interest in all discussions developed around the quality of financial statements. Second, there is a broad interest in the findings documented by such literature, given the fact that all users of accounting information need to be informed in the process of decision making. Third, biased earnings are not accepted by the accounting standards and such practices must be limited.

The remainder of this paper is organized as follows. The first segment comprises the overview of our research questions and the research method used, followed by the discussion segment. The conclusion, limitation and scope for future research segment are the last ones approached.

2. Revisiting the research profile, research question and research method

This assessment of the profile of contemporary published earnings management practices is aiming to augment the literature by analyzing and summarizing the evidences of the papers approaching such area of research. As such, the analysis can be used further in order to evaluate, identify and address future research agendas. In doing so, our paper answers one related research question, as following: *What is the scholarship field of trade-off between accrual-based and real earnings management research?*

In terms of research method used for selecting and reviewing the papers selected, a similar method as in Guthrie et al. (2012) was used. In this respect the review process comprised five different stages. Similar to Guthrie et al. (2012) our first stage was used for formulating the core research objectives. The second stage comprised the selection of the journals. In this respect we have selected the traditional top leading accounting journals as documented by Chan et al. (2009). The third stage comprised the selection of the articles. In the search of the papers assessed, specific keywords to accrual-based earnings management, real earnings management and trade-off effect. Our search was concept-centric and not author centric. All PDF versions of the papers were downloaded and stored in an Endnote database together with the referencing details. In the fourth stage, we examined independently the PDF full versions and excluded the papers with only a marginal earnings management focus.

3. Findings and discussions around the preferences of managers regarding the two types of earnings management

There is substantial empirical evidence that managers are using earnings management (Burgstahler and Eames 2006; Roychowdhury 2006; Chen et al. 2011). While accrual-based earnings management refers to managers' opportunistic use of the flexibility allowed under General Accepted Accounting Principles to change reported earnings without changing the underlying cash flows, real-based earnings management comprises managers' opportunistic timing and structuring of operating, investment and financing transactions to affect reported earnings in a particular direction. Such latter demarches results in a sub-optimal business consequences and usually imposes a real cost on the firm.

Despite the fact that both earnings management types are extensively examined in the literature, very few empirical studies examined in the same time both types of earnings management. The core idea is that when we are examining only one types of earnings management practices, the real magnitude of manipulative behavior cannot be assessed thoroughly. In particular, if managers use accrual-based earnings management and real earnings management to accomplish the same objective, examining only one type of manipulation in isolation may lead to an understatement of the overall level of earnings management as stated above (Darrough and Rangan, 2005; Mizik and Jacobson, 2008). If managers' use of accrual-based and real earnings management is offsetting, focusing on either type of manipulation at a time for one purpose will only provide partial evidence and perhaps result in incorrect conclusions.

There is a relatively little analytical investigation and some mixed empirical evidence on how managers choose between accrual-based versus real earnings management. On the one hand, recent empirical evidence document that managers use both types of earnings management to meet earnings targets. The empirical study conducted by Burgstahler and Dichev (1997) document that both cash flow from operations and changes in current accruals are managed to increase earnings, while Burgstahler and Eames (2003) document that both cash flow from operations and discretionary accruals are managed upwards to avoid reporting earnings lower than analyst forecasts.

The empirical study conducted by Zang (2012) provides large sample evidence that managers do trade off using accrual earnings management and real earnings management to achieve their objectives. Similarly, Barton and Simko (2002) and Pincus and Rajgopal (2002) presented

evidence that managers use derivatives and discretionary accruals as partial substitutes for smoothing earnings. While such studies attempt to examine the link between accrual-based earnings management and real earnings management by correlating these two decision variables, a comprehensive approach to investigate managers' choice of the types of earnings management is to examine their relation to exogenous firm or to managers' characteristics.

This particular study attempts to fill that void in the earnings management literature in an effort to advance the understanding of managers' financial reporting behavior, by summarizing the main results documented in this area of research.

One of the first empirical studies documenting that the managers usually tradeoff between the two types of earnings management was conducted by Graham et al., (2005). In this regard, although real earnings management has not been as widely studied as accrual-based earnings management, Graham et al.'s (2005) survey finds that managers prefer real activities manipulation.

The main practices of real earnings management comprise actions as reducing discretionary expenditures over accruals manipulation as a way to manage earnings. Such real earnings management activities are significantly different compared to accrual-based ones as they have direct cash flows effects. The results documented by Graham et al. (2005:32) find strong evidence that managers take real economic actions to maintain accounting appearances. Moreover, in particular, 80% of survey participants report that they would decrease discretionary spending on R&D, advertising, and maintenance to meet an earnings target. In this regard, more than half (55.3%) state that they would delay starting a new project to meet an earnings target, even if such a delay entailed a small sacrifice in value.

The main reasons documented in the literature for executives' willingness to manage earnings through real activities than through accruals, comprises various arguments as: accrual-based earnings management are more likely to draw auditor or regulatory scrutiny than real decisions or using accrual manipulation alone can be risky. In regard of the latter argument, when reported income falls below the threshold and all accrual-based strategies to meet it are exhausted, managers are left with no options since real activities cannot be adjusted at or after the end of the fiscal reporting period. On the other hand, when the firm's growth prospects are good, the firm will try to increase current period earnings using accrual-based earnings management but not real earnings

management. Also, when the sensitivity of the manager's compensation to stock price and/or market pricing of earnings increases, managers engage in accrual-based earnings management to increase current period earnings. A third case when accrual-based earnings management is preferred by managers is when the cost of using real earnings management is too high.

The theoretical arguments approached in the frameworks are also assessed in empirical studies documenting the existence of the tradeoff between the types of earnings management. In this respect, four empirical studies can be cited: Zang (2012); Baderschert (2011); Burnett et al. (2012) and Roychowdhury et al. (2012).

For instance, Zang (2011) examined if managers uses real earnings management and accrual based earnings management as substitutes in order to manipulate earnings to reach benchmarks. Managers are using as substitutes the two types of earnings management and after identified realized real earnings management, managers modify the level of accrual-based earnings management accordingly. The frequency of comprising such demarches depends on the relative costliness of adopting an earnings management practices (Zang, 2012). The study conducted by Baderschert (2011) investigated the overvaluation of companies and the association with both earnings management types. Since the overvaluation impacts accrual-based earnings management, real earnings management is also affected by the company`s valuation decisions. The empirical study conducted by Baderschert (2011) documented that companies that are in the initial stage of overvaluation engage more frequently in accrual-based earnings management and during later stages subsidies to real earnings management.

Burnett et al. (2012) researched also the trade-off between stock-repurchases and accrual-based earnings management. The goal of the paper was to assess if companies under constrained possibilities to use accrual-based earnings management engaged in real earnings management by using stock repurchases. Roychowdhury et al. (2012) investigated the role accrual-based and real earnings management in the overvaluation in SEO periods. The documented results show that managers are using more real earnings management compared to accrual-based earnings management, despite the negative long-term effect on firm`s performance.

Summarizing the main findings in the tradeoff area of research, it can be concluded that companies are using both types of earnings management strategies to manage their earnings (Cohen and Zarowin, 2010; Dechow et al., 2011; Badertscher, 2011; Kothari et al., 2012).

Real earnings management is considered to be more expensive compared to accrual-based earnings management (Graham et al., 2005; Kim and Sohn, 2013), and it can be used throughout the year, while accruals earnings management is generally more constraint to specific times and periods (Zang, 2012). Unlike accrual-based earnings management, real earnings management has an impact on cash flow which can affect the company on long run (Gunny, 2010). Being more difficult to detect real earnings management, such practices are not normally under the jurisdiction of any existing auditing system and less subject to extensive controls and external monitoring by society, including media scrutiny or other political parties (Kim and Sohn, 2013).

Since all managers of companies are aware of the rewards of meeting or beating earnings target they are motivated to choose among the alternatives earnings management strategies (Bartov et al., 2002). In cases where both earnings management methods are likely to be used, the literature document evidence that managers trade-off between two earnings management strategies based on their relative costs and benefits, using accrual-based and real earnings management as substitutes (Ewert and Wagenhofer, 2005; Cohen et al., 2008; Cohen and Zarowin, 2010; Zang, 2012).

4. Conclusion, limitations and scope for future research

The goal of our paper was to review the most recent field regarding the tradeoff between accrual-based versus real earnings management and to discuss the main findings and is not meant to be a definitive framework for earnings management research area. Moreover this study can be a useful instrument in identifying future areas of research.

In this respect we can assert that previous empirical examined both measures of earnings management, which various incentives to manage earnings are documented all around the world. In this respect, even if accrual-based earnings management practices are documented extensively, recent years have documented more and more real earnings management practices (Cohen et al., 2008; Seybert, 2010; Badertscher, 2011). Despite the fact that both earnings management types are extensively examined in the literature, very few empirical studies examined in the same time both types of earnings management. There is a relatively little analytical investigation and some mixed empirical evidence on how managers choose between accrual-based versus real earnings management. On the one hand, recent empirical evidence document that managers use both types of

earnings management to meet earnings targets but further research is necessary in order to understand how managers trade between the two types of earnings management.

Our research has one important limitation. We assessed only published work, excluding working papers or conferences proceedings papers. By doing so, we limited very much our area of interest and the number of papers from earnings management research field.

Further research can examine the effect of financial transparency increase on earnings management types or the impact of ethics. Also, future research designs should bring significant improvements when assessing the existence and magnitude of earnings management types and assessment of the tradeoff effect, given the fact that contemporary research designs are suffering from important measurement errors. Also, future research can concentrate on items of high importance of: income smoothing assessment, the impact of financial crisis over manipulation behavior, personal traits impact over earnings management activities, etc. Those future research agendas can open up new fields of enquiry, addressing either neglected areas of research either consolidating previous areas of earnings management research. Also, future research should also consider exploring previous findings using qualitative research including interviews with managers, investors or other users of accounting information.

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PARTICIPATION IN THE PROCESS OF PRIMARY SCHOOLS FINANCIAL PLANNING – AN ATTEMPT TO CONCEPTUALIZE AND OPERATIONALIZE THE PROBLEM

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Abstract. *The paper presents a concept of participation-based structuring of expenses in public primary schools. The proposed model refers to the assumptions of Target Costing, and the applied solutions ensure relatively high consistency of cash allocation directions and amounts of expenditures with the needs reported by students' parents. The product of linking the needs with activities will be the usefulness of services provided by schools, which translates directly to ensuring efficiency, cost saving and productivity in these organizations' performance.*

Keywords: *participation, planning, structuring, expenses.*

1. Introduction

Public organizations, which are among the most important and active participants of the economic life, are obliged to provide public services targeted at citizens and other stakeholders. Due to the characteristics of their operations, they are largely financed with public funds. Therefore, all units of organization qualified to the public finance sector, including primary schools, are required to perform effectively, i.e. to demonstrate efficiency, cost savings and productivity. In this context, an important area of study, both theoretical and practical, in the field of management of schools is the streamlining of their activities and reducing wastage caused by lack of awareness or non-compliance with the management standards

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presented in the theoretical concepts or implemented in practice, including those applicable to commercial organizations.

Taking actions to maximize the level of achievement of anticipated targets with minimizing the financial and moral costs is closely linked to the goals of public organizations, focused on long-term fulfillment of the needs of citizens and other stakeholders of these organizations. It is an important issue to recognize these needs and to be able to employ the information obtained in service provision processes. In this context, one of the key issues related to the functioning and efficiency of primary schools is to ensure consistency between cash allocation directions and amounts of expenditures with the needs reported by students' parents as the recipients of education services.

The purpose of this paper is an attempt at presenting a participation-based expenses structuring model in public organizations and justifying its usefulness in the process of increasing cash-oriented financial systems through ensuring the adequacy of expenses for the needs of public service recipients.

The paper employs contemporary concepts describing organizational efficiency, selected elements of systems theory, and the target costing tools adapted to the requirements of budget accounting.

2. Participation in the theory of public management

During the recent years, participation of individuals in decision-making processes is being applied more and more extensively in activities of local governments. The typical reason for using these mechanisms is the willingness to gain support, or to follow a "trend" for participation, and not an attempt at delegating decisions to others.

The word "participation" is frequently associated with the concept of direct democracy, which is usually referenced to present a model of State government [See 15, p. 13]. The understanding of participation in the perspective of direct democracy is frequently rejected because, despite that the legitimacy to rule is considered a common feature, appropriate participation activities are in fact used to restrain democratic institutions. In that context, participation does not stand for democratic representation but only constitutes an auxiliary and separate system [See 6, p. 62].

Thus, the concept of participation not only refers to information exchange but also to interaction and influencing [See 10, pp. 9-10]. Information exchange is an obvious element of developing solutions satisfactory to various interest groups but at the same time it contributes to

creating interactions that are a prerequisite of good cooperation and harmony among citizens and other stakeholders, whether affecting or affected by the organization. The effect is a state of balance (social order) among the participants.

Influencing remains the essential activity in the participation process, which is linked to ruling. Therefore, in a general sense, participation refers to improved communication between the citizen and the public administration, giving citizens the ability to influence decisions taken by public institutions. This is achieved, *inter alia*, through [See 6, p. 63]:

1. civil initiatives presented to competent authorities by voluntary associations and unions (in the form of motions and opinions),
2. demonstrations and petitions,
3. discussions and joint action organized by the administration,
4. formation of mixed teams and committees.

"Participation" is often complemented with an adjective or descriptor specifying its type more precisely, e.g. staff participation, community participation, public participation, etc.

Community participation is linked to independence and voluntary self-organization of citizens for the purpose of resolving a problem that affects the entire community. Such activities should therefore be identified with all types of bottom-up actions initiated by the citizens themselves, e.g. through the Internet.

On the other hand, public participation refers to citizens' participation in public management processes. Therefore, the latter comprises all methods and mechanisms with various levels of citizens' influence on the decisions that are being taken, while at the same time depending on public authorities' readiness to acknowledge the role of local inhabitants as joint decision-makers [See 2, p. 7]. The process occurs as between the citizens and the public government, with the objective of engaging the local inhabitants in taking decisions that concern them.

The participation theory first introduced by S. Langton [See 8] focuses on four basic forms of citizens' participation in social life, namely: political activity, citizen engagement, participation in elections, and mandatory participation. The legal status and practice allows pointing to the presence of public activity and citizen engagement in Poland. However, participation in election and mandatory participation are not applicable.

Public activity is defined mainly through self-organization of citizens intending to influence the decisions taken by the government. In Poland, public activity is typically undertaken as [See 12, pp. 49-50]: taking part in

elections, referendums and community consultations, organizing events or setting up support groups, or working in non-government organizations.

S. R. Arnstein [See 1, pp. 216-224] in her study on public activity distinguished certain types of citizen engagement using a "participation ladder". The central point of the adopted classification is a comparison of powerless citizens and rulers, while through emphasizing the discordance between these groups, eight types of participation grouped in three levels can be distinguished (Figure 1).

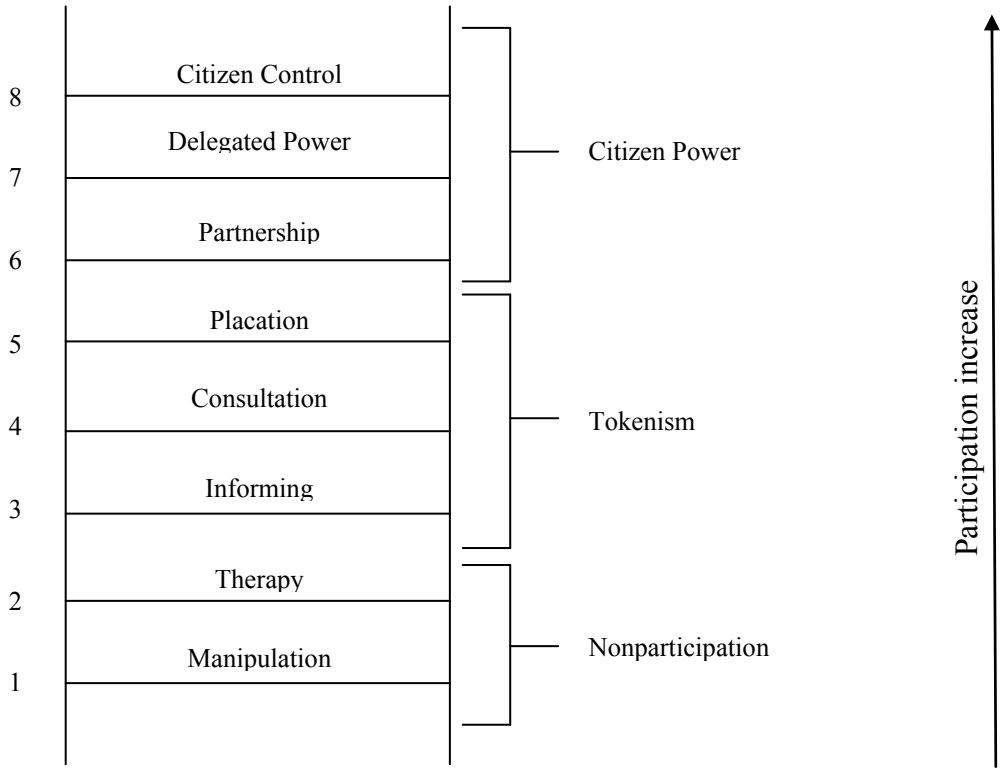


Figure 1. The ladder of participation.

Source: own research, based on: 1, p. 418.

The lowest rungs of the ladder are: manipulation and therapy, which are perceived non-participatory by the author of the concept. Activities involving information, consultation or placation are referred to as tokenism.

Only the three upper rungs in the proposed model, namely partnership, delegated power and citizen control, are considered true participation (citizen power). They are the only ones that give the society an opportunity to give advice or even to take specific decisions which are then implemented by public authorities or authorized third parties.

The possibilities of engaging citizens in matters concerning the given society or community by public authorities are relatively broad. Namely, engagement in public affairs can take place through [See 2, p. 9]: informing, consultation, involvement, collaboration, and empowering. These activities are consistent with the requirements of the five-point scale of engagement levels developed by the International Association for Public Participation (IAP2), namely: *inform, consult, involve, collaborate, and empower* [See 5].

Informing means communicating such knowledge to citizens which would not only enable them to understand the problem but also point to available alternatives, opportunities or solutions for the given issues. The function of informing the society of public affairs is incorporated in the classic functions of public administration. The right to public information is guaranteed to citizens by Article 63 of the Constitution of the Republic of Poland [See 7], as well as on the level of appropriate Acts of law. The basic means of information are: [See 14]

– announcing public information in the Public Information Bulletin, displaying or presenting such information to the public in generally accessible locations,

– admission to meetings of the authorities,

– placing the information in the central repository of public information.

Unlike informing, the purpose of consultation is not limited to making the general public aware of the proposed undertakings but is primarily aimed at obtaining opinions that would more or less significantly affect the quality of these proposals [See 3, p. 24]. With the focus on feedback, social consultation takes up various forms, starting with surveys and polling (online polling included), through gathering opinions by councilors, to direct meetings with citizens.

Involvement, according to the IAP2 guidelines, requires direct cooperation with citizens, with the goal of ensuring proper understanding and incorporating both the social concerns and aspirations in public policies. In this context, collaboration of the government and the society is indispensable at every stage of the decision-making process. Through creating a platform of cooperation with citizens, public authorities not only undertake to consider but also to maximize the implementation in their activities of the local community's ideas, advice, concerns and aspirations [See 5]. Collaboration normally occurs through informal workgroups, comprising both the local inhabitants and representatives of the authorities [See 2, p. 9].

The final form of inclusion of citizens in the public affairs is delegating, or empowering the society to take the final decisions. In the socio-political reality, delegating takes place mainly through decision making by representatives of the community – usually representatives of non-government organizations – who are members of teams in charge of producing draft decisions. Local people are seldom engaged in such activities, despite that their participation in the process is most important from the contemplated viewpoint [See 2, p. 9]. Certainly, this type of participation comprises participatory budgeting, which has been gaining popularity recently. This mechanism allows engaging both non-government organizations and citizens in the decision-making process.

3. Level of detail in allocation of budget expenditures in the operating conditions of primary schools in Poland

Planning and settlement of budget expenses of public finance sector units, including primary schools, occurs in Poland in accordance with the provisions of Public Finance Act of 27 September 2009 (Journal of Laws of 2009, No. 157, item 1240). Primary importance was given to budget classification which, as a consolidated system for grouping budget incomes and expenses, provides grounds for in-depth analysis (comparison) of the State's socio-economic assumptions with sources of budget incomes and expenses. Therefore, it is a uniform system of digital codes and names used to ensure transparency of budget resources flow within the framework of the executive system.

Therefore, this classification is an instrument that guarantees order in budgetary planning and budget records, as well as one of the tools to facilitate financial discipline control.

Based on the above assumptions, under Article 39(1) of the above referenced Act of law, public expenditures are classified by:

– divisions and sections – identifying the types of activities,

– sub-sections – identifying the types of expenses.

Divisions and sections are characterized by strict allocation, meaning that every section can come under one division only. This rule does not apply to sub-sections.

Thus, the structure of budget classification in Poland is based on divisions, which are divided into sections, and the latter in turn are divided into sub-section. By way of exception, only with regard to the State budget, the largest classification scale is a part.

The particular budget classification scales vary in characteristics. Parts are identified mainly by their subjective character, although some parts were created in view of the objective character (e.g. earmarked reserves, central government subsidies for local government units). Divisions present the budget in functional terms and are distinguished according to the criteria of public activity areas. Sections go deeper into division classification and are distinguished on the basis of the criteria of types of activities (e.g. geodesic and cartographic works, financial support for investments), or on the basis of classifications distinguishing entities performing public functions (e.g. the Office for Foreigners, the Pharmaceutical Inspection). Sub-sections, in turn, group incomes by source and expenditures by function. [See 4]

As noted by A. Majchrzycka-Guzowska [See 9, pp. 38-39], the presented classification method allows for distinguishing the following criteria for allocation:

- by subject, in which budgetary incomes and expenses are divided into parts corresponding to the current division of government administration into ministries, where each of the ministry units is the trustee and the party responsible for implementation of a specific part of the budget,
- by object/by function, in which incomes are divided by source of origin and expenses by target function, and therefore budgetary incomes and expenses can be assigned to divisions and sections,
- by nature, which extends the classification by object/by function with sub-sections and items and therefore facilitating exact determination of amounts spent on the particular specific tasks.

Details concerning budgetary classification are set forth in Regulation of the Minister of Finance of 2 March 2010 concerning detailed classification of incomes, expenses, proceeds and outlays as well as funds from foreign sources

Public expenditures are further structured according to additional classification specifying the codes for structural expenses, i.e. the national public spending in the areas of intervention of structural funds in relation to execution of operations and goals set out and defined in the appropriate Regulation of the Minister of Finance. Structural expenditures include expenses that constitute the national contribution for execution of projects co-financed with structural funds, as well as expenditures on implementing projects financed from national sources only, corresponding to the areas and intervention category codes of structural funds.

A detailed classification of expenses and structural expenditures is given in Regulation of the Minister of Finance of 2 March 2010 (Journal of Laws 2010 No. 38, item 207). At the same time, Public Finance Act allows establishing more detailed classifications than the basic classification for tasks involving internal and external security, taking into account the characteristics of units involved in pursuing tasks in this field.

Apart from accounting, budgetary classification is also used in planning, and the level of detail in this respect is set by separate legislation. This is expressed in practice by financial plans and their modifications being prepared in full detail of the classification system (down to sub-sections, inclusive).

Considering the above presented legal considerations, incomes and expenses shown in financial plans of primary schools are prepared according to the following level of detail:

Division: 801 – Schooling and education

Section 80101 – primary schools

INCOMES

§ 0690 – proceeds from various charges,

§ 0750 – incomes from lease and rental of assets owned by the State Treasury, local government units or other units from the public finance sector, or other similar agreements,

§ 0830 – proceeds from services,

§ 0920 – other interest,

§ 0960 – inheritance, bequests and donations received as monies,

§ 0970 – proceeds from miscellaneous revenues.

EXPENSES

§ 3020 – personnel expenses not recognized as salaries,

§ 4010 – salaries of named employees,

§ 4040 – additional yearly remuneration,

§ 4110 – social security contributions,

§ 4120 – contributions for the Labour Fund,

§ 4140 – contributions to the State Fund for Rehabilitation of Handicapped Persons (PFRON),

§ 4170 – unnamed salaries,

§ 4210 – purchases of materials and equipment,

§ 4220 – purchases of food,

§ 4240 – purchases of learning aids, teaching aids and books,

§ 4260 – purchases of energy,

§ 4270 – purchases of renovation services,

§ 4280 – purchases of health services,
§ 4300 – purchases of other services,
§ 4360 – charges for purchase of telecommunication services,
§ 4400 – administration fees, rent for buildings, premises and garages,
§ 4410 – business trips, domestic,
§ 4430 – miscellaneous fees and contributions,
§ 4440 – amounts written down to Company Social Benefits Fund,,
§ 4520 – payments to local government units' budgets,
§ 4700 – training for personnel other than civil servants,
§ 6060 – expenditures on investments of budgetary units.

Consequently, an attempt at structuring the expenses would necessarily involve planning 22 detailed items required under the applicable laws.

4. Expense accounting for participation-based standardization of primary schools' operations

The requirements concerning participation of citizens and other stakeholders in planning the activities of primary schools, as well as the legal conditions of the process indicate that determination of a structure of expenses standardized to the participation system should comprise the following stages:

1. Identification of functions performed by the school (F_i, where $i = 1,\ 2,...,\ n,\ n$ – number of identified functions);

2. Estimation of the values describing the advancement of execution of the specific functions F_i, based on evaluation by citizens and other stakeholders being the target of the school's activities (a_i for each $i = 1,\ 2,...,\ n$);

3. Determination of the total amount actually spent on the provision of the given service (D) and expenses, to the required level of detail (D_j, where $j = 1,\ 2,...,\ m,$ and m is the number of identified types of expenses with the adopted level of detail $\left(D = \sum_{j=1}^{m} D_j \right)$;

4. Identification of expenses serving the purpose of executing the specific functions F_i assigned to the given service in the current operating conditions of the organization, taking into account an evaluation of

performance of these functions (D_i^a. for each $i = 1,\ 2,...,\ n$), according to the following formula: $D_i^a = \frac{a_i}{\sum_{i=1}^{n} a_i} D$;

5. Determination of existence of a relationship between the expense, to the required level of detail, and the function performed F_i on the basis of evaluation by experts – owners of the process (b_{ij} for each $i = 1,\ 2,...,\ n$ and $j = 1,\ 2,...,\ m$);

6. Determination of the values of weighting coefficients (h_{ij} for each $i = 1,\ 2,...,\ n$ and $j = 1,\ 2,...,\ m$) setting the degree to which specific expenditures are related to execution of the functions identified for the given public service, according to the following formula: $h_{ij} \equiv \frac{d_{ij}^a}{D_i^a}$, where d_{ij}^a are the values of expenses for each applicable level of detail for the function performed F_i which are the solution of the following system of equations:

$$\begin{cases} b_{11}d_{11}^a + b_{12}d_{12}^a + ... + b_{1m}d_{1m}^a = D_1^a. \\ b_{21}d_{21}^a + b_{22}d_{22}^a + ... + b_{2m}d_{2m}^a = D_2^a. \\ \vdots \\ b_{n1}d_{n1}^a + b_{n2}d_{n2}^a + ... + b_{nm}d_{nm}^a = D_n^a. \\ b_{11}d_{11}^a + b_{21}d_{21}^a + ... + b_{n1}d_{n1}^a = D_{.\,1} \\ b_{12}d_{12}^a + b_{22}d_{22}^a + ... + b_{n2}d_{n2}^a = D_{.\,2} \\ \vdots \\ b_{1m}d_{1m}^a + b_{2m}d_{2m}^a + ... + b_{nm}d_{nm}^a = D_{.\,m} \end{cases};$$

7. Identification of weightings that define the importance of the identified functions F_i for their recipients, on the basis of evaluations by citizens and other stakeholders (v_i for each $i = 1,\ 2,...,\ n$),

Executive managers (heads of communes, mayors of towns, heads of organizational units, etc.) supplementing the importance weightings with the legal, social, political and other requirements according to the characteristics of the relevant legal systems, political systems etc.;

8. Determination of expenses standardized according to participation standards for the specific functions F_i for the given public service, taking into account the importance weightings identified for these functions ($D_{i\,.}^{t}$ for each $i = 1,\ 2,...,\ n$), according to the following formula: $D_{i\,.}^{t} = \frac{v_i}{\sum_{i=1}^{n} v_i} D$;

9. Determination of the values of expenses standardized according to participation standards for selected functions F_i with the adopted level of detail (d_{ij}^{t} for each $i = 1,\ 2,...,\ n$ and $j = 1,\ 2,...,\ m$), according to the following formula: $d_{ij}^{t} = h_{ij} \cdot D_{i\,.}^{t}$;

10. Determination of the aggregate value of expenses standardized on a participation basis for the given public service, to the required level of detail ($D_{.\,j}^{t}$ for each $j = 1,\ 2,...,\ m$), according to the following formula: $D_{.\,j}^{t} = \sum_{i=1}^{n} d_{ij}^{t}$.

The presented manner of proceeding offers information concerning the structure of expenses recommended from the perspective of citizens and other stakeholders, ensuring efficient performance of public services at a local government unit. The actual expenses, notwithstanding the expression as costs of consumption of the organization's specific resources, will be relatively consistent with the needs of participants of local government communities, and their standardized structures and target values will ensure high efficiency, productivity and cost saving for the implemented activities.

The process of identifying the functions of services performed at the given local government unit (F_i) is particularized both through specific goals and through socio-political and economic relations, as well as the information requirements stated by public managers for a management accounting system. Thus, determination of the functions assigned to specific public services requires interdisciplinary collaboration between

representatives of decision-making bodies as well as executive bodies of the given unit of organization. Contemplating the goals for tasks, services provided and functions or their groupings – notwithstanding the assumptions attributed to the proposed model – is a major added value that serves the purpose of streamlining the management systems.

Current assessment of the status of identified, clearly and comprehensively described functions of public services (a_i) should be conducted with the use of statistical measures (e.g. median of ratings given in the opinions gathered). Therefore, opinions need to be gathered from a representative group of citizens and other stakeholders who are the intended recipients of the given public service.

The amounts of expenses actually incurred (D_j) are determined on the basis of accounting records where, according to the adaptation assumptions for target costing, this is an achievable level of expenses according to the currently applied procedures for provision of public services [See 11, p. 287]. Thus, another role of the proposed standard costing model is to specify the intended value that the expenses should reach in the conditions of consistency with the expectations of citizens and other stakeholders as well as the intentions of public managers concerning organizational efficiency. Nevertheless, it should be expressly pointed out that actual changes in the structure of expenses require a process change and not only a transfer of funds within the framework of the given unit's financial plan. Only in this way will adaptation processes ensure successful adaptation of the presented model.

An important problem in the proposed model is the determination of proportion of expenses identified in the specified level of detail in execution of identified functions (h_{ij}). According to the process applied in target costing, these values are identified using QFD (Quality Function Development) matrix in which you build a so-called House of Quality to identify the values sought on the basis of client requirements ranking [See 13, pp. 118-121]. The strength of the dependencies between the specific types of expenses and public service functions in the applied scale (strong: 9 points, medium: 3 points, weak: 1 point) should be set by the owners of the process of rendering the given public service. Evaluations of the strength of the relationship between the expense to the required level of detail and the function performed, based on expert ratings, can be recorded in a matrix $B=[b_{ij}]_{n\times m}$, where b_{ij} means the strength of the relationship

between $j-$ th expense to the required level of detail and i–th function performed, $b_{ij} \in \{0, 1, 3, 9\}$.

In the proposed model, calculation of the values of expenses serving the purpose of performing the specific functions according to the adopted level of detail (d_{ij}^{a}) requires that the sums of expenditures on function execution and the sums of expenses to the applied level of detail equal the amount of expenditures allocated to the given function and to the amount of expenditures in the given area as defined by the applied level of detail, respectively (Diagram 1). The calculations of these involve evaluations by process owners, specifying only which expense served the purpose of performing the specified functions, without stating the impact strength, i.e.

$$b_{ij} := \begin{cases} 0, \; dla \; b_{ij} = 0 \\ 1, \; dla \; b_{ij} \in \{1, 3, 9\} \end{cases}.$$

At the same time, it should be assumed that the inequality present in the calculation process between the number of unknowns and the number of equations must be balanced through applying certain additional assumptions expressed as the relationships adopted for the given local government unit, representing consistency of the structure of certain expenses, to the expected level of detail, or consistency of that structure with other categories related to the progress of tested processes – like in the process of determining allocation keys for indirect costs in the cost calculation system. This task makes the proceeding more difficult and the effect will depend, among other factors, on the level of involvement of the actors and process owners - internal participation.

The conclusion of the discussed process is the calculation of expenditures standardized on participatory basis D_j^t (Diagram 1). It is preceded by estimating the validity of the particular functions (F_i) for citizens and other stakeholders (v_i) and expenditures standardized on participatory basis for individual functions (D_i^t) of the evaluated public service. Identification of weightings that define the importance of the identified functions F_i is carried out in the same manner as the current evaluation of performance of these functions.

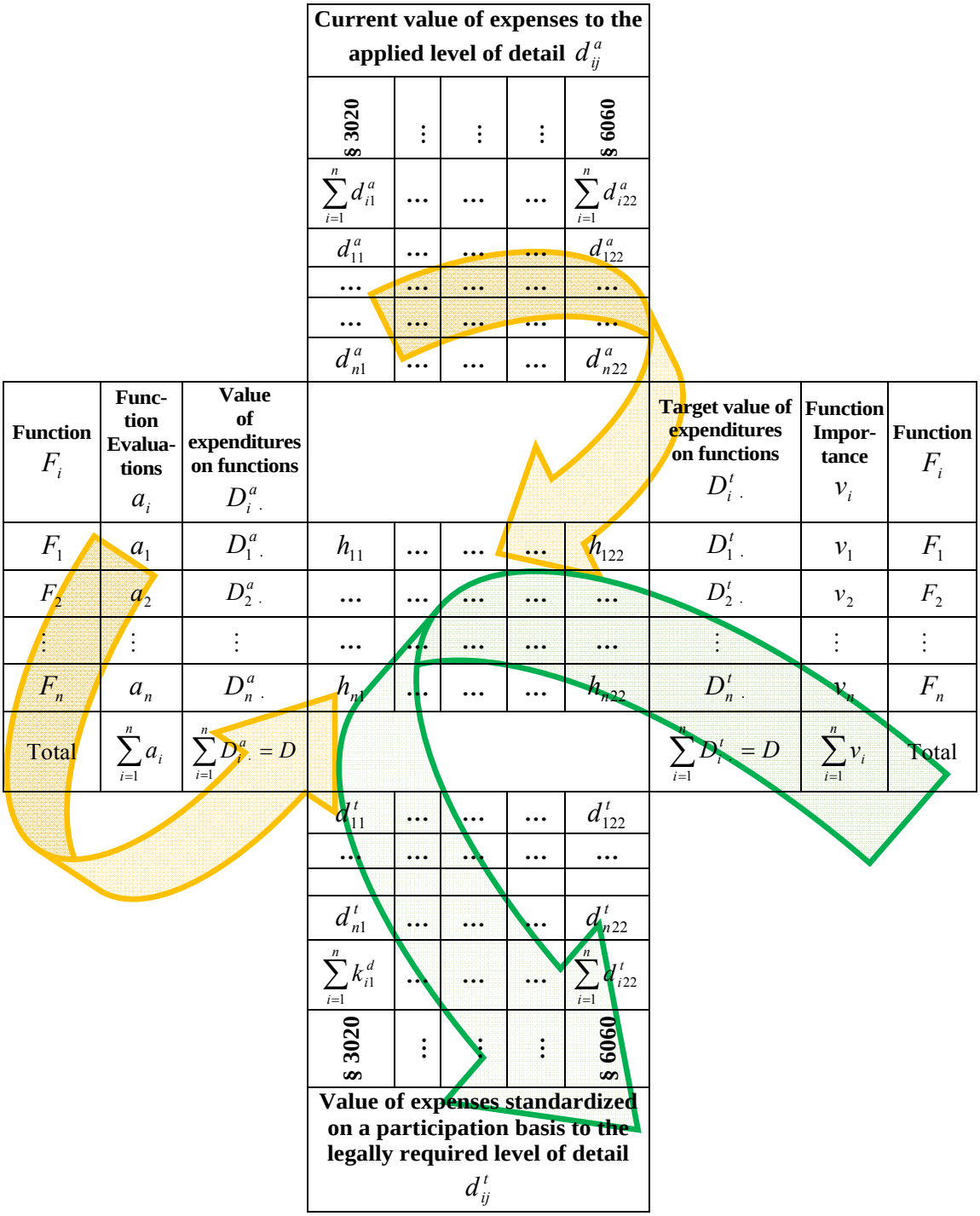


Diagram 1. The process of participation-based structuring of expenses at primary schools.

Source: Own research

The structure of expenditures structured on participatory basis that is developed through the procedure presents the expenses to the anticipated level of detail, in such values that ensure theoretical consistency with the needs of the citizens and other stakeholders, and meet the compliance requirements being a prerequisite of the local government unit's activities.

5. Conclusion

It has been demonstrated in the course of the argument that the solutions proposed in target costing can be adapted to cash structured finance management systems at public primary schools in Poland. The participation-based standardization model presented in this paper for these organizations' expenses allows for determination of the amount of expenditure at a level relatively close to the values required for high efficiency of these organizations. The values obtained should be the basis for works targeted at such goals as changing the procedures for providing educational services so as to modify the coefficients defining the degree to which specific expenses are linked to performance of the functions identified for that service. As a consequence, solutions will be identified leading to movements within personnel expenditures, spending on purchases of materials and energy, use of outsourced services etc. Therefore, analysis of deviations between the actual structure of expenses and the structure standardized on the basis of participation standards further contributes to seeking new alternative processes for providing education services and seeking reference processes that would ensure efficiency of specific activities related to the provision of these services.

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SHAPING INNOVATION-ORIENTED EMPLOYABILITY – EXPERIENCE OF PUBLIC HOSPITALS[1]

Joanna A. JONCZYK*

Abstract. *The aim of this study is an attempt to define and identify innovation -oriented employability in public hospitals. First, an analysis of the literature was performed and a preliminary standard employability pattern conducive to innovation was formulated. The basis of study was empirical research conducted in 2014 in 8 Polish hospitals, attended by 467 respondents. The analysis used the Kruskal-Wallis test (ANOVA rank Kruskal-Wallis) and the calculation was performed using STATISTICA 10. The results clearly indicate the problem of public hospitals with the use of incentive systems that rewards the achievements of innovative employees, as well as difficulties in encouraging staff to take risks and experiment on the job.*

Keywords: *employability, innovation – oriented employability, personnel practices, innovation, public hospitals.*

1. Introduction

In the context of the new economy, as an essential condition for the survival and development of the organization innovation is considered. At the same time, due to the fact that human resources (people) are generators of new or creatively transformed solutions the proper use of these resources is necessary (Borkowska, 2010). This view is of decisive importance in the context of employability, which in turn is an important element for rapidly adapting organizations and their staff to change operating conditions. In connection with the above the conscious development practices that identify and modify competence or motivation towards innovation are necessary. However, it is difficult to find empirical studies on the relationship between employability of innovation, particularly in public hospitals. This problem seems all the more

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interesting, that the independent public health care institutions apply different solutions from the private sector of management resulting from the peculiarities of health services and the specific characteristics of the environment, organizational structures and processes (Frączkiewicz-Wronka, 2009) that take place in these entities. Therefore, the aim of this study is to attempt to define and identify (favorable) employability-oriented innovation practices in public hospitals. First, an analysis of the literature was performed and a preliminary standard employability conducive to innovation was formulated. Then the methodology of the research was described and results of own empirical research conducted in 2014 in 8 hospitals operating in Poland were presented. The study involved 467 respondents, of which the largest group consisted of nurses and midwives. The analysis used the Kruskal-Wallis (ANOVA rank Kruskal-Wallis) and the calculation was performed using STATISTICA 10. In summary of the publication proposals were described, but stressed were the limitations of the study and attempt to determine the prospects for further scientific inquiry concerning the organization and favorable employability-oriented innovation practices.

2. The framework of the study (innovation and employability)

In the new economy the concept of innovation has a fixed interest from both practitioners and researchers – theorists. It can be considered that innovation is the most current requirement for the development of modern organization, which means the ability to create, deploy and absorb innovation involving the possession of resources and the ability to use them. At the same time it should be emphasized that the concept of innovation is multidimensional and its interpretation depends on context in which it applies. Therefore, in the literature there have been many attempts to define the concept. One of the first undertook Hurt defining innovativeness as readiness to change (Hurt, Joseph and Cook, 1977). Goldsmith and Hofacker recognize innovation as both attitude and behavior (Goldsmith and Hofacker, 1991). Still other authors associate innovation with a set of features such staff openness, entrepreneurship, willingness to change and the ability to innovate and be creative (Berthon, Hulbert and Pitt, 1999; Blake, Neuendorf and Valdiserri, 2003; Hult,

Hurley, Knight 2004 , Cowart et al. 2007; Menguc and Auh, 2006). It is interesting that in the few studies of innovation in hospitals, there are two distinct perspectives. The first limits the roles of hospitals to the main consumers of innovation in the health sector (Kimberly & Evanisco, 1981, p. 691). In turn, the second treats these entities more precisely in the context of their staff (doctors, nurses, managers) as the main generators of innovation (Arndt & Bigelow, 2000, pp. 497-498). However, regardless of the perspective and from a management perspective it can be assumed that innovation in hospital depends on connections, predispositions and behaviors of employees and organizational factors, based on which hospitals can influence and create internal innovation potential. The synergy of these factors is reflected, inter alia, by human resource management practices, including employability. Although the concept of employability raises many controversies (Pocztowski, 2007), but generally can mean the ability to work and maintain employment. One of the reasons for the inclusion of this concept to the contemporary discourse of management is the phenomenon of employment slowing (downsizing) combined with the fast pace of obsolescence of skills of human resources due to changing technology (Clark and Patrickson, 2008). At the same time, there are different approaches to employability. Van der Heijde and Van der Heijden (2006) indicate conceptualization of employability based on broad competencies. Hence the term chances on the labor market (including domestic) of persons as "continuous satisfactory acquisition or creation of jobs through optimum utilization of competence" (Van der Heijde and Van der Heijden, 2006). In other words, the possession of certain competencies should enable employees obtaining and keeping a job. From the point of view to develop i.e. to identify employability-oriented innovation in public hospitals conceptual categories play an important role, such as: innovative competence and motivation to be innovative. Innovative competence can be defined as properties, the entity's ability to affect its posture in the innovation in including the ability to create and implement innovations (propensity and ease to undergo innovation processes and the ability to learn). In turn, the innovative motivation mechanism is aimed to accept the news, generating the individual's attitude towards innovation (the desire to implement or rejection of the innovation). Innovative competence, innovation and motivation are all associated with a sense of reasonableness and pro-

innovation action by an employee and are of advantage to the objectives of the organization. Hence, it is important to consciously shape the competence and motivation of staff leading to the development of adaptability (Fugate et al., 2004), mobility (Van Dam, 2005), professional experience (Van der Heijde and Van der Heijden, 2006), or for personal development and learning training (Bezuijen, 2005). Therefore, the formation of innovative organizations, including hospitals should foster the use of certain practices that stimulate innovation of workers. In this context, it was found that employability-oriented, innovation is mainly developed due to the ability of organizations to obtain and maintain employment through the optimal use of innovative competence and motivation. By analyzing a number of compounds of practices of personnel innovation (Searle & Ball, 2012; Tan and Nasurdin 2010; Chen and Huang 2009; Shipton, Fay, West Patterson, and Birdi, 2005; Darroch and McNaugton, 2002; Jackson and Schuler, 1995; Nonaka and Takeuchi, 1995; Hedlund, 1994; Sparrow, Schuler and Jackson, 1994; Galbraith, 1984; Katz and Kahn, 1978) we recognized that employability-oriented innovation should focus on recruitment of employees characterized by creativity and openness to change, employees aimed at development, staff assessment taking into account criteria such as innovation, creativity, as well as motivating employees to be innovative and rewarding activity and its results. It is worth noting that the development of innovation-oriented employability of workers in public hospitals also needs to accept the specificity of these organizations. This specificity is due to both the peculiarities of the health care market, as well as the so-called the audience-distinctive features of public hospitals that differ from private organizations (Kożuch 2004, Frączkiewicz - Wronka, 2009). It should be emphasized that the objectives of public hospitals are numerous, multidimensional and often difficult to reconcile, for example equality, justice and efficiency. Managers in these organizations manage the number of a variety of purposes, more than business organizations and they need to reconcile the expectations of a larger number of stakeholders. In public hospitals the organizational structure is characterized by a high formalization, are inflexible and decision-making procedures are often too strict (Sulkowski, Seliga 2012). In the context of managing people, high cultural diversity is worth emphasizing, resulting, inter alia, from the operation of various professional groups (subcultures) (Trice, Beyer,

1993). The differences in the mentality of individual professional groups subcultures are so important that they often complicate the personnel management (Palthe, Kossek, 2003), and this in turn may hamper the development of practices regarding the employability of innovation-oriented hospitals.

3. Research Methodology

In the context of the aim implementation, the surveys, which were conducted in 2014 in 8 public hospitals operating in two regions in Poland were used (choice of hospitals was intentional, resulting from the fact that only these organizations have expressed their willingness to participate in the study). The employment in selected hospitals ranged from 70 to 100 employees (doctors, nurses and managers) in each, generally covering 640 employees in both provinces. The largest employment group consisted of nurses and midwives (about 70% of the workforce). Doctors accounted for approximately 20%, managers approx. 10% of workforce. A total of 467 questionnaires were analyzed, of which the largest part, because more than half of the survey was complemented by nurses and midwives (in total 285 questionnaires). Other survey comprised mainly of doctors (100 surveys) and managers (including: directors and their deputies, managers, heads of the wards, departmental nurses – 82 questionnaires). To achieve the objective of the work analysis of variance (ANOVA) was carried out comparing whether respondents' opinions regarding various practices regarding the employability of innovation-oriented hospitals differed significantly among themselves. The answers given by respondents were coded on a five-point ordinal scale (1 to 5) where 1 means "definitely not" – 2 "rather not", 3 "no opinion" – 4 "rather yes" and 5 "strongly yes". In the context of the definition of employability-oriented innovation (organization's ability to obtain and maintain employment through the optimum use of the competence and motivation of innovative) the respondents' attitudes to the following statements were studied: "In the process of recruiting the staff we take into account the characteristics of the candidates associated with openness to change and creativity" "Employees are encouraged to experiment and take risks", "Employees are encouraged to develop and share knowledge", "The staff appraisal system takes into account criteria related to creativity and innovation" and "In the hospital

there is a system of incentives that rewards the innovative employees". However, because of ordinal nature of the variables and being aware of non-compliance with the assumptions of classical analysis of variance (no normality in subgroups due to the sequential nature of the data, the presence of heterogeneity of variance) Kruskal-Wallis test was performed (Kruskal-Wallis ANOVA rank). The calculations in the study were performed using STATISTICA 10. The Cronbach Alpha index value reliability of the scale for the analyzed variables was quite high, as was 0.79. The answers of the respondents were analyzed in relation to key staff representing three professional groups (doctors, nurses/midwives and managers). The adoption of such an assumption was associated with the subculture dominated by the medical profession characterized by public hospitals.

4. The results of research

The first of the tested practices within the concept of innovation-oriented employability related to personnel selection takes into account such candidate features as openness to change and creativity (Figure 1).

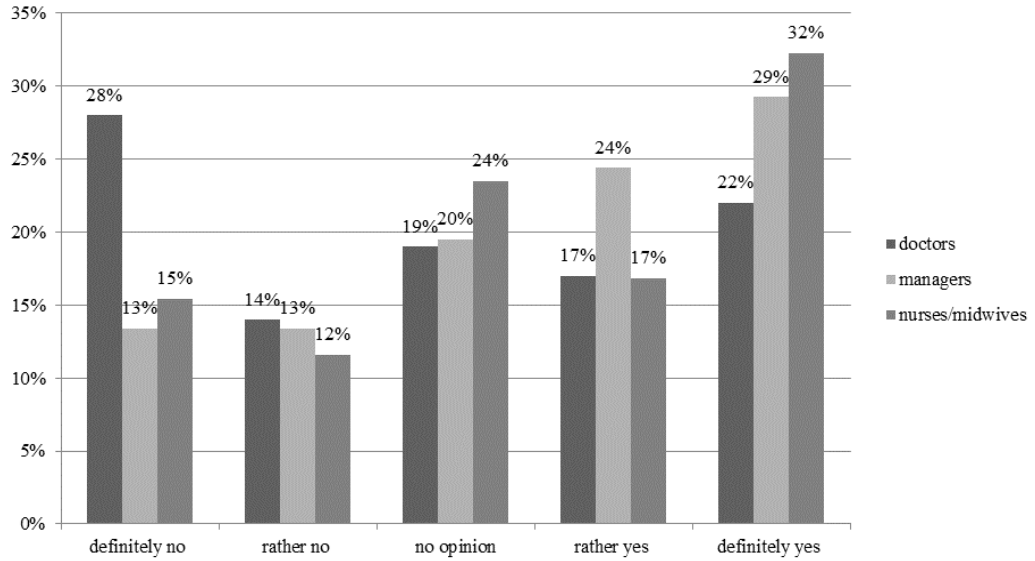


Figure 1. Results of analysis of variance for variable personnel selection of candidates taking into account characteristics such as: openness to change and creativity (divided into professional groups).

Source: own research.

As it is clear from the data distribution, opinions of respondents concerning the application of hospital personnel selection of candidates taking into account characteristics such as openness to change and creativity are different in different occupational groups. And so a positive response (a combination of answers "rather yes" and "definitely yes") granted by 53% of managers and 49% of nurses / midwives and 39% of physicians. At the same time many negative responses (42%) gave a group of doctors, which may indicate a weak interest of doctors in management people practices while an enhanced focus on their own tasks, primarily related to clinical decision making. In the case of nurses and managers negative opinions were much lower, which in turn may result from greater interest than in the case of doctors, in management personnel practices.

Next investigated practice applies to encouraging staff to experiment and taking risk. Data distribution is presented in Figure 2.

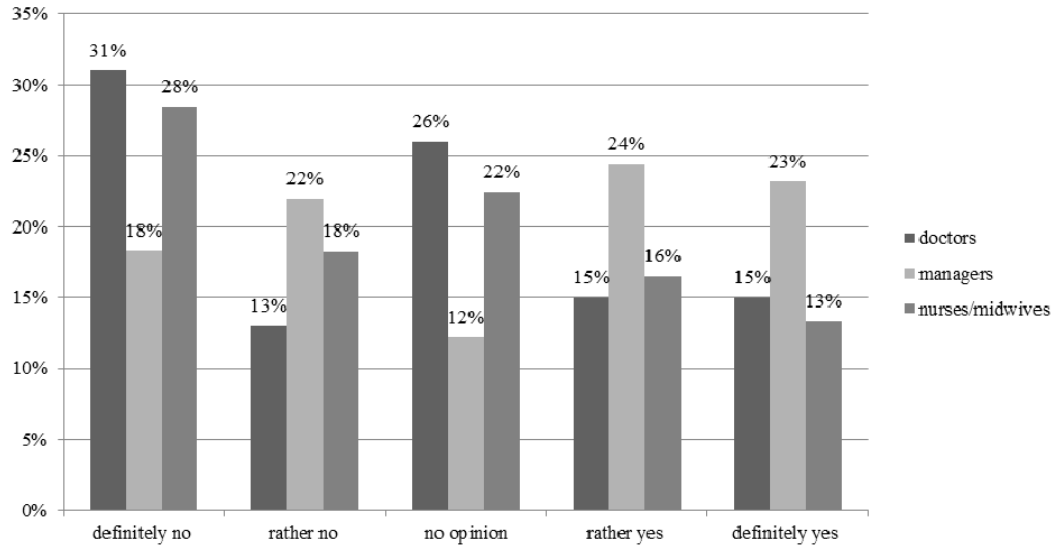


Figure 2. The results of analysis of variance for the variable practice of encouraging staff to experiment and take risks divided into professional groups.

Source: own research.

In this case, the assessment of practices to encourage staff to experiment and risk taking were largely negative and many respondents did not express any opinion at all. Most negative assessments (a combination of answers "rather not" or "definitely not") expressed both

medical professional groups (doctors – 44% and nurses – 46%). At the same time 47% of managers positively (combination of answers "rather yes" and "definitely yes") rated the issue of encouraging staff to experiment and take risks. Such opinions of respondents may arise from different mentality and approaches to the problem of risk taking by medical personnel and managers. As Freidson pointed out, these groups have different levels of tolerance for uncertainty at work (Freidson, 1972). For managers, unlike in the case of doctors and nurses / midwives, tolerance for uncertainty at work is greater.

Another were analyzed feature was to encourage staff to develop and share knowledge (Figure 3).

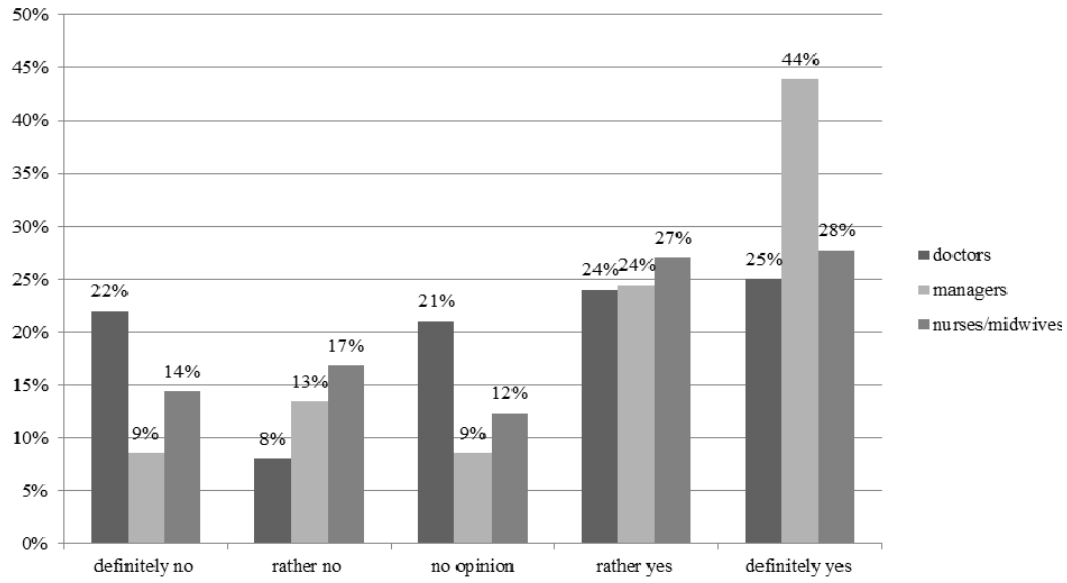


Figure 3. Results of analysis of variance for the variable “practice of encouraging staff to develop and share knowledge” (divided into professional groups).

Source: own research.

As can be seen from the distribution of data for this practice, it is dominated by positive responses (a combination of answers "rather yes" and "definitely yes") of 55% of nurses and midwives and 68% of managers. In case of physicians, 49% expressed a positive assessment. It is worth noting that a large group of doctors (30%) expressed a negative

opinion on this issue. This may be due to the fact the formation of new expectations among medical personnel on the continuing support of organization especially in the range of knowledge and development, particularly against so rapid changes in medicine.

Another practice for innovation-oriented employability was the use of appraisal system that takes into account creativity and innovation in hospitals (Figure 4).

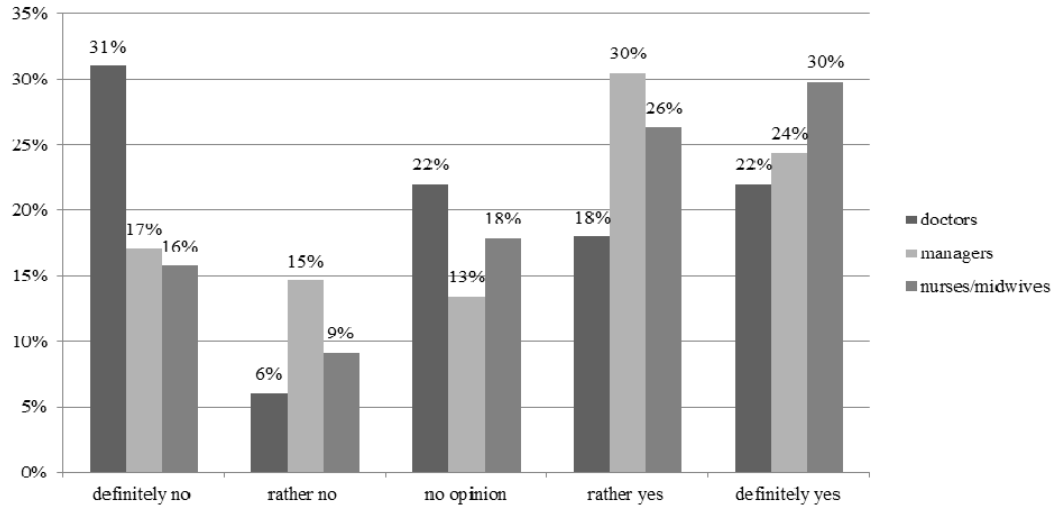


Figure 4. The results of analysis of variance for the variable appraisal system takes into account criteria related to creativity and innovation with a breakdown by business.

Source: own research.

By analyzing these results, it should be noted that in the opinion of the majority of respondents rating of this practice were positive. Positive ratings (combination of answers "rather yes" and "definitely yes") granted 54% of managers, and 56% of nurses and midwives. And again positive feedback from doctors was the lowest among the occupational groups surveyed (40%). This situation may indicate a weak interest in this professional group of assessment processes. Such opinions of doctors may also be linked to an overall reluctance to judge and at the same time high self-evaluation of the medical community and therefore difficulty in accepting criticism from others.

The last tested practice subjected to analysis and evaluation was the application of the incentive system rewarding innovative actions of workers. Results of Kruskal-Wallis test with respect to this practice are shown in Figure 5.

As it is clear from the data distribution, most of the ratings on the occurrence of an incentive system rewarding workers were negative. So negative assessment (combination of answers "rather not" or "definitely not") covered 58% of doctors, and 53% nurses and midwives. And among managers 49% of respondents expressed a negative opinion. At the same time 40% of managers positively (combination of answers "rather yes" and "definitely yes") rated the practice of motivation.

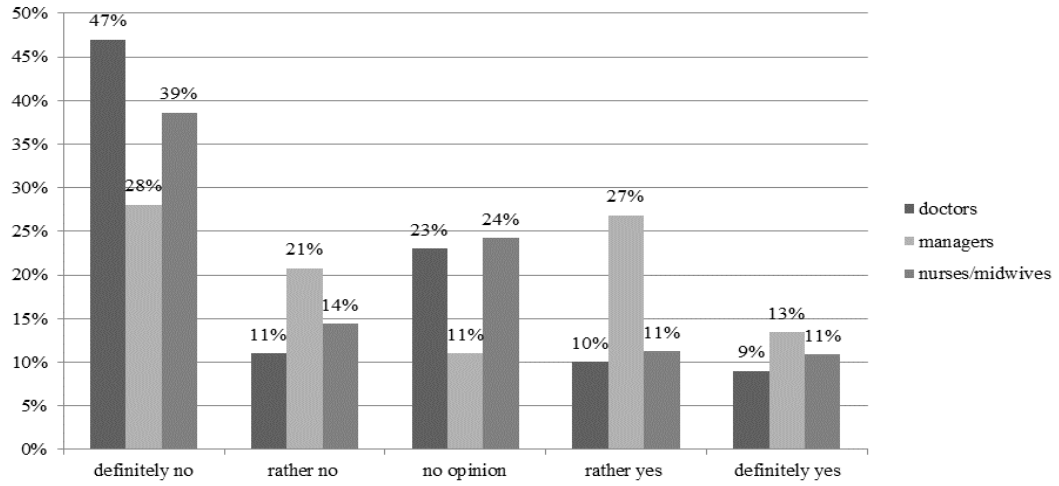


Figure 5. The results of analysis of variance for the variable "incentive system rewarding innovative workers" (divided into professional groups).

Source: own research.

This situation may result from the specifics of managerial work, because on the one hand, managers manage subordinate staff, and on the other hand, are subordinates. It is difficult in these conditions to motivate staff; especially the objectives and needs of the organization do not always coincide with the goals and needs of employees. In turn, the negative opinions of doctors and nurses may be due to the fact of discontent caused by the amount of wages, especially among nurses and midwives. At the same time the negative assessment of this practice may be related to the

inconsistency between motivation solutions used in the surveyed hospitals and the specificity of work of individual professional groups.

5. Conclusions and limitations of the study

The study shows that the growth of innovation imperative in public hospitals implies the need to shape the employability conducive to innovation. Here it is important that hospitals have obtained the ability to obtain and maintain employment through the optimum use of the innovative competence and motivation. However, in this regard opinions of respondents are divided. As presented in the results, statistically significant differences apply to all occupational groups investigated. And so, in the opinion of most managers they received a positive assessment of practice "selection staff taking into account such characteristics of candidates as openness to change and creativity" and the practice of "encouraging staff to develop and share their knowledge". The less positive assessment was granted to the practice of "taking risk, experimenting and the presence of an incentive system to reward innovative achievements of the staff". In the case of nurses, most of the positive reviews concerned practices that "encourage staff development and share of knowledge" (as in managers) and "employee evaluation system that takes into account criteria related to creativity and innovation". In the other two assessments of practices by nurses were more negative. On the other hand, the lowest assessment of all practices within the employability of innovation-oriented was set by doctors. Only in relation to the practice of "encouraging staff to develop and share of knowledge" 49% of this group of respondents expressed a positive opinion. In summary it can be assumed that the weakest link in the innovativeness-oriented employability in the surveyed hospitals is the lack of an incentive system rewarding innovative employees and the lack of encouraging staff to experiment and take risks. It is worth mentioning that the lack of incentive for innovation by many authors was pointed to as a fundamental obstacle in the development of pro-innovative people management practices (Amabile, 1988; Kanter, 1983) and requires removing from the way to the development of innovation in organization. In the event of a practice of encouraging risk and experimentation a clear message from management

should occur in hospitals that supports such actions and is ready to bear the risk associated with testing of new products and services. Management should create values that promote risk-taking and demonstrate that it is it good behaviour (Arad, Hanson, Schneider, 1997). At the same time, it is important to ensure freedom of workers in decision-making. On the other hand the best respondents received a positive evaluation practice of encouraging staff to develop and share of knowledge. This situation testifies to the growing awareness of the need for development of hospitals staff, especially in such complex and variable conditions of the functioning of the health sector.

As seen from the above image, innovation-oriented employability research in the surveyed hospitals requires changes. Hospitals need a comprehensive approach to the test problems by raising the level of implementation of all practices related to obtaining and maintaining employment for the development of innovation. At the same time, it is necessary here to take into account the needs and expectations of the various professional groups and their verification with the objectives of hospitals. In summary, the studies are not free from limitations. First of all, there are significant differences between numbers of respondents in groups, which probably affected the results (but it was not possible to acquire a larger number of surveys of smaller groups which are in every hospital doctors and managers). Furthermore, the survey covered only the selected hospitals. The selection of the sample was not random, which is largely associated with serious reluctance of hospitals for this type of research. Despite these limitations, it seems that the results obtained may, however, provide guidance to chief executives of hospitals in relation to the need for stronger innovation-oriented employability practices of these organizations. At the same time it should broaden the scope of research on other practices, such as: labour relations and career planning so that a greater degree model innovation-oriented employability.

The concept of innovation-oriented employability presented in the article shaped hardly a theory, but can certainly serve as a starting point for a better understanding of the issues and further empirical research. Such studies seem to be quite urgent, especially that the literature increasingly pointed to the need to effectively attract and retain staff, in particular professionals, whose competence and motivations are a key success and innovation factor.

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ROMANIAN YOUTH EMIGRATION: SOCIO-ECONOMIC AND DEMOGRAPHIC IMPLICATIONS

Mariana BĂLAN*

Abstract. *The migration of young Romanians is a component of great interest for the general phenomenon of labour migration in Romania. The magnitude of the phenomenon is difficult to outline only through the current official statistics, which do not capture all its sides and cannot provide a complete and accurate picture of it.*

This phenomenon leads to a crisis situation on the labour market and on the insurance and social services market, in the sense that it carries a much higher pressure on employment in the labour market in Romania, and the changes in age groups' structure and population gender, coupled with decreasing fertility rates lead to continuing demographic aging, as well.

The paper analyses the economic, social and demographic consequences of the youth emigration in recent years. The negative effects are highlighted (e.g., specialists' loss or diminishing local potential labour force), but also a number of positive effects of migration of the young labour force (remittances, the formation of links with Diaspora, and facilitating the exchange of experience, or at times even providing jobs for some professional groups which cannot be absorbed by the domestic market). The continuous decrease of the youth and especially, increasing the share of young women emigrants' leads to accelerated aging of the population. The negative consequences of this phenomenon are also analysed, at family level, such as imbalances in the couple relationship (including divorce), abandonment of children, school dropout, etc. at the national level.

Keywords: *youth emigration, economic and social implications, demographic impact.*

JEL Classification: *E24, F22, J11, J13, J24, J31, O15*

1. Introduction

The issues facing youths and those related to their migration have been the focus of attention for the world bodies already as of the year 1994

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at the International Conference or Population and Development from Cairo, and then in the year 1995 once the Youth Action World Programme was adopted.

The information about youths' migration is, more often than not, collected from population census data or from administrative surveys. At world level, in the year 2013, young migrants represented a significant weight of the migrant stocks, respectively over 12% from the 28 million young individuals aged between 15 and 24 years of age [7].

The reasons for which youths migrate are multiple. Sometimes, a combination of several major factors leads to their decision to migrate. Personal considerations, socio-economic circumstances and the political situation in the country of origin can be regarded as main reasons of emigration. More often than not, the size of the inequalities perceived by the young about the labour market opportunities, about incomes, human rights and standards of living in their countries of origin and in the countries of destination can lead to the migration decision. Other young individuals emigrate in view of family reunion, of marriage or for pursuing tertiary education abroad. The migration provides to youths opportunities of employment in decent and productive jobs, of improving their social and economic status, and of learning new skills, etc.

Women and girls represent an important component of international migration for the last six decades. Thus, as of 2010, approximately 49% of the emigrants at world level were women. Even though the databanks regarding the size and structure of migration flows were improved significantly during the last years, still, the information about the migration of teenagers and young aduls (age group 15-24 years of age) disaggregated on genders is difficult to find in many of the studies regarding this field.

The effects of external migration are positive and negative, as irrespective if it is definitive or temporary, migration is a form of human capital export. Globally, and cumulated on short-, medium- and long-term, external migration represents a loss for the country of origin and a gain for the country of destination.

For ***emigration***, the flow of individuals being unidirectional and definitive, the losses for the country of origin are total. The costs borne by the country of origin include both expenditures for education and training of the migrant individual, to which are added the future costs/loss by neutralising the labour capacity in activities of the national activity. To these can be also added costs/losses related to the consumption of goods and services of the national output, the effects of population diminishment as they leave and no longer contribute to the natural growth, losses at cultural level, etc. For some countries, youths' emigration shall emphasise

the demographic decline. The diminishment in the fertile age population leads automatically, in time, to the decrease in the number of new-borns. Moreover, the cyclicality of these mechanisms once established, deterioration can only increase.

In the case of ***labour migration*** the flows are multi-directional, repetitive and of variable frequency. The costs involved by this phenomenon are the higher when the migrant person is more educated, with increased labour and innovation potential. The potential benefits of temporary migration have a higher certainty degree and, for each migration cycle, the costs-benefits balance is different as net effect.

For the country of origin, irrespective of the external migration form, the human capital export, of labour force for which important investments were made represents a loss of value added that could have been achieved in the country, which is a source of economic growth. To these are added also other losses from among which: reduced resources to the state budget from taxes, duties and contributions associated to labour incomes; lower contributions to the social funds; changes of the social-professional structure on the national market with future labour effects on the employees; changes for the age structure of the working age population that is its ageing; the low demand for goods and services required for current consumption, etc.

The gains for the country of origin are low and very often postponed. From among them the most important are: the demand for goods and services paid by remittances from abroad; stimulating investments or developing small-businesses; productivity increase and labour quality; satisfying, even temporary, the demand on the labour market, etc.

2. Amplitude of migration and characteristics of young migrants in the new international conjecture

The migration phenomena/processes/youths' labour force mobility are of particular complexity, multi-dimensional and polyvalent, difficult to decipher in their entire texture and amplitude. These are under the incidence of a multitude of factors, the action of which intersects stimulating or to the contrary hindering the migration or mobility processes of the labour force. Even if they develop on the background and under the conditions of economies' globalisation which, by definition, means also the liberalisation of labour force movement, they are hindered by institutional-national constraints, behavioural limitations of the population

in the areas, regions and countries of destination, restrictions resulting from the adjustment difficulties of the newcomers, a.s.o.

Youths' migration can be either forced or voluntary. Natural circumstances or ones triggered by man can determine youths to migrate. Also, youths can involve in circular migration. Traditionally, this type of migration was limited to seasonal labour activities in agriculture, such as harvesting crops, vegetables and fruits. More recent, an increase was registered in the number of international students. Also, several multinational corporations and bodies in transnational partnerships participate to placement activities of the employees and trans-border exchanges of the latter that can vary from a few months to several years.

Voluntary migration for labour, study or family reasons is more widespread than forced migration. International statistics show that only 15 from 232 million international migrants were refugees in the year 2013 [18]. Even if approximately 60% of the young emigrants come from developing countries, still the number of young emigrants in the age group 15 to 24 years of age, as percentage of total youths varies considerably from one country to the other, depending on the development level of the country. In 2013, 9.1% of the young migrants originated from developed countries and only 1.4% from developing countries.

The high number of youths studying abroad is in continuing increase. From 1975 up to 2009, the number of foreign students enrolled in tertiary education increased over four times (from 0.8 million to 3.6 million individuals). Even though the number of foreign students continues to increase, both in developed countries and in the developing ones, the increase is more marked for the latter. In the year 2010, most foreign students (84%) were enrolled in educational institutions from developed countries with the highest weight in North America and Western Europe (58%). The data provided by the UNESCO Institute of Statistics indicate that East Asia and the Pacific are the main source for international students (representing 28% from total international students). The United States of America were the most popular destination for foreign students, representing 19% from their total, followed by the United Kingdom of Great Britain and Northern Ireland (11%), Australia (8%), France (7%), Germany (6%), and Japan (4%).

International global migration among youths underwent an increasing trend in the last decades: from 154 million in 1990 to 175 million in the year 2000, 221 millions in the year 2010 and 232 million in the year 2013, the last year for which data are available[17]-[8]-[9]. For the year 2013, it

is estimated that 28.2 million migrants had ages between 15 and 24 years of age (Figure 1) which represents approximately 12% from total migrant population. The number of young migrants increased from 23.2 million in the year 1990 to 28.2 million in the year 2013 [16].

The analysis of the data in Figure 1 indicate that the weight of migrants with ages between 15 and 24 years of age is, in general, higher in the developing countries than in the developed countries, and the most are from the countries designated as "least developed countries" (Figure 1). This fact could be explained, partially, by the fact that the continuing flow of young immigrants replaces older generations of migrants thus leading to an insignificant ageing of the migrants' population in the countries of destination.

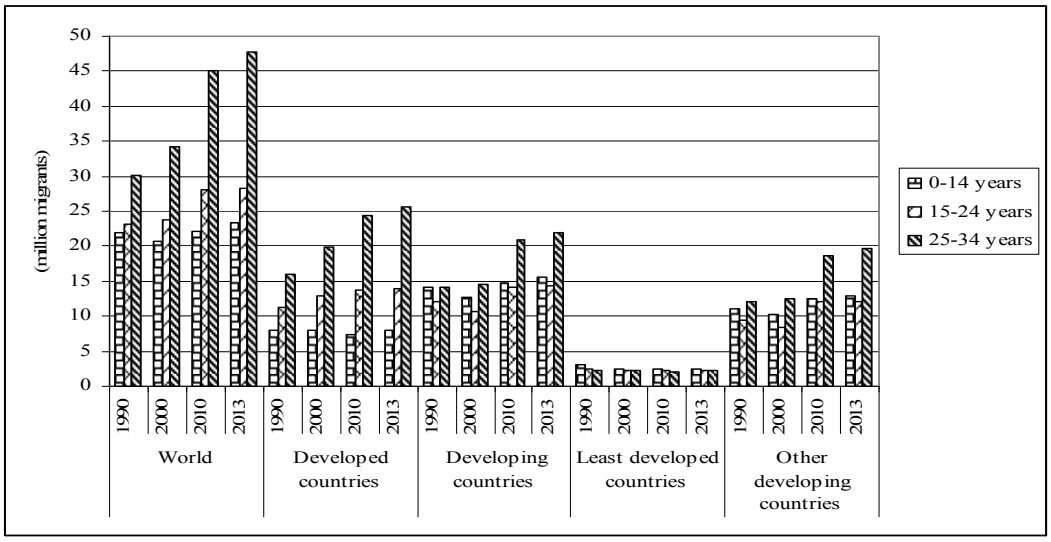


Figure 1. Evolution of the number of young emigrants, on age groups and country groups.

Data source: United Nations, Department of Economic and Social Affairs, Population Division, 2013, Trends in International Migrant Stock: Migrants by Age and Sex (United Nations database, POP/DB/MIG/Stock/Rev.2013).

In the year 2013, the young emigrants with ages between 15 and 24 years of age represented 10.2% from the international migrants to developed countries, 14.9% in the developing countries, and 20.9% in the least developed countries.

With respect to the destination of young emigrants, from the data provided by the UN Report[1],, developed countries hosted in 2013 58.6% from total international migrants, and almost half (49.1%) from those with ages between 15 and 24 years of age (Figure 2).

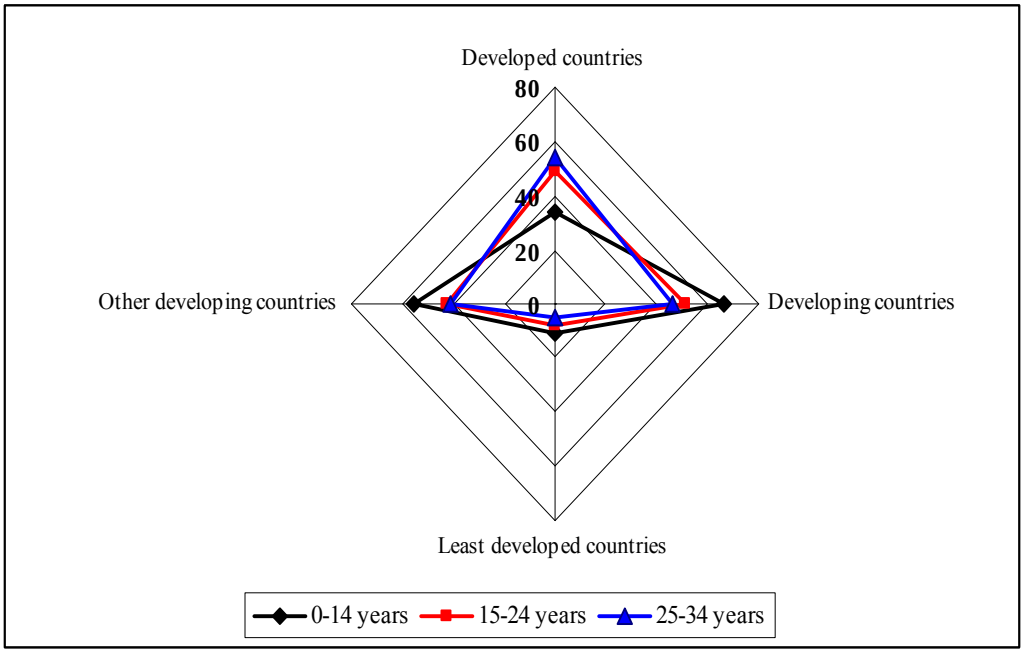


Figure 2. Percentage distribution of migrants on age groups and country groups in the year 2013.

Data source: United Nations, Department of Economic and Social Affairs, Population Division, 2013, Trends in International Migrant Stock: Migrants by Age and Sex (United Nations database, POP/DB/MIG/Stock/Rev.2013).

With respect to the structure on genders of young migrants, the statistical data indicate that at global level, 46.5% of the migrants were young women or girls, a percentage similar with the one of women in total migrant population (48%) (Figure 3). The analysis of the graphs from Figure 3 indicates that the weight of women in migrant population decreased slightly for all age groups (at world level from 48.8% in 1990 to 48% in 2013) and for almost all categories of countries. The exception is represented by developed countries where in the period 1990-2013 the

[1] United Nations, Department of Economic and Social Affairs, Population Division, 2013, Trends in International Migrant Stock: Migrants by Age and Sex (United Nations database, POP/DB/MIG/Stock/Rev.2013).

weight of women and girls in total emigrant population registered a slight increase. For instance, per total, the weight of migrant women increased from 51.2% to 51.6% and the weight of young migrant women with ages between 15 and 24 years of age increased from 48.4 pp to 48.9 pp.

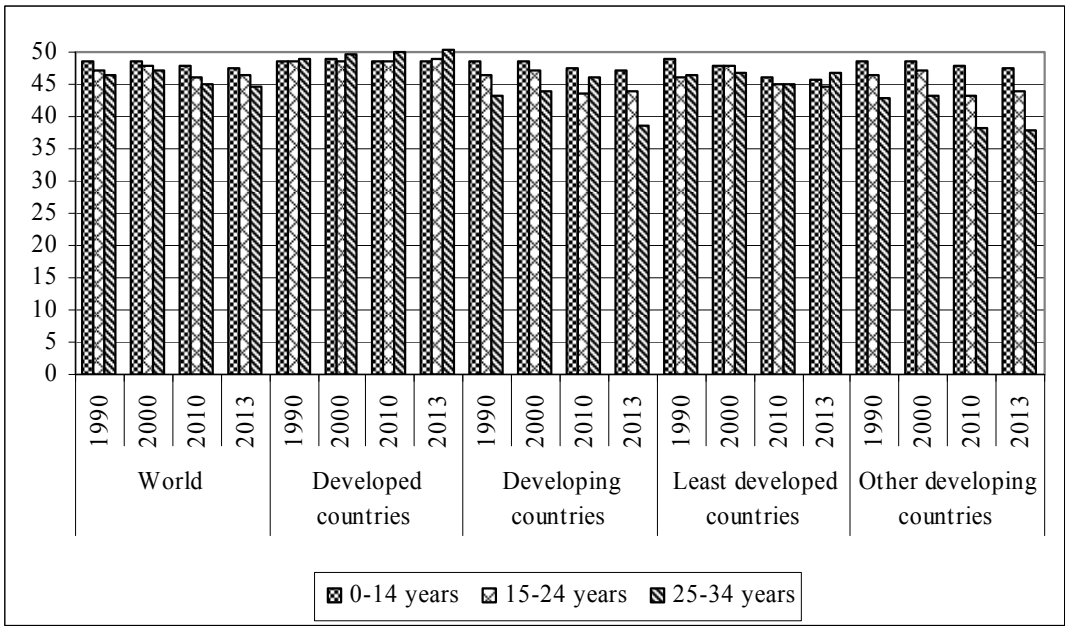


Figure 3. Evolution of women's and girls' weight in international migration flows.

Source: United Nations, Department of Economic and Social Affairs, Population Division, 2013, Trends in International Migrant Stock: Migrants by Age and Sex (United Nations database, POP/DB/MIG/Stock/Rev.2013).

At global level, based on the statistical data, it was estimated that between 2000 and 2013 the most significant increase in the numbers of young immigrants took place among those with ages between 30 and 34 years of age (2.7%), followed by the young individuals with ages between 25 and 29 years of age (2.4%).

3. Socio-economic and demographic impact of youths migration

Migration affects both young migrants and their families remaining in the countries of origin. The effects of emigration are complex and can be influenced by factors such as the type of emigration, the emigrants' category, national emigration policies, as well as by the programmatic

interventions that are adopted in the countries of origin, transit or destination [12].

International migration can improve social and economic welfare of young migrants and contribute to higher economic efficiency in the countries of destination.

The migration of skilled young individuals represents an opportunity for the destination countries and a net loss for the countries of origin. The direct impact of considerable brain drain shall diminish the economic growth in the countries of origin [10]-[4]. Intellectual talents have always migrated to the cultural-scientific and production centres that provided not only higher incomes, but also increased career opportunities; possibilities of verifying in practice their own theories and hypotheses, and to stronger display their creative spirit.

For the countries of destination, the immigration of skilled personnel has net and consistent beneficial effects on their local sustainable development, for at least three reasons[2]:

a) highly skilled individuals, as a rule, work in the sector of export goods, which is more competitive than the sector of non-exportable goods and services, with a superior productivity of labour and capital;

b) in general, the wages paid to highly skilled immigrants are lower than the ones paid to autochthonous workers for the same performance level;

c) the drive to succeed in career, innovativeness and creativity is higher for immigrants than for the national residents;

d) the skilled personnel, as a rule, does not access social assistance funds but, to the contrary, it contributes to diminishing the fiscal pressure of the native inhabitants and to increasing the local budget.

For the country of origin the most important negative effect is represented by the loss of a significant share of skilled labour force. On one hand, the country of origin can no longer benefit from the investment in human resources by putting to good use the competences on the job, and on the other hand, the migration of specialists can led to the diminishment of technological development, of economic growth, wages, and labour

[2] Estimarea impactului liberei circulații a lucrătorilor români pe teritoriul UE, începând cu 01.01.2014; realități și tendințe din perspectivă economică, ocupațională și socială, la nivel național și European [Estimating the impact of free movement of Romanian workers on the EU territory as of 01.01.2014; realities and trends from economic, occupational and social perspective at national and European level], European Institute from Romania, Strategy and Policy Studies – Spos 2013, Study, no. 3

force employment in certain sectors of activity. The competitiveness decreases as specialists leave, and maintaining the link to the job left behind (by projects/collaborations, etc.) does not compensate for the created deficit, but maintains it. This deficit cannot be eliminated by other immigrant workers, as they come with lower skills, or are just in transit towards countries with stronger economies.

Work abroad brings with it financial advantages because it is accompanied by remittances [14]. Yet, the longer the period of mobility, the more is the danger of making the stay permanent and thus resulting in net losses for the country of origin, such as: losses of human capital, moving the household, of ceasing or drastic diminishing the remittances' flow, eliminating the possibility of return and reemployment, diminishing local consumption, etc., but with sustainable advantages for the labour market and business environment in the host-country.

In the year 2013, the remittances' flow to the developing countries totalled 441 billion USD. The estimates of international bodies show that countries receiving the highest amounts of money are India (71 billion USD), China (60 billion USD), the Philippines (26 billion Euros), Mexico (22 billion USD) and Nigeria (21 billion USD). In relationship to the gross domestic product, the remittances for the year 2012 represented 48% in Tajikistan, 31% in Kyrgyzstan, 25% in Lesotho and Nepal and 24% in the Republic Moldova [3].

Still, young individuals without family and with career perspectives on the labour market in the host-country send less money to the parents' households in the country, and on medium- and long-term they are much more inclined to finalise their mobility by setting up a family and changing the residence. The determinant vector for the volume of remittances shall remain the number of mobile workers with secondary studies and with ages up to 40 years of age, with dependant family in the country (husband/wife and children), preponderantly in the rural area.

Youth migration/mobility has a series of positive effects but also negative from among which the following can be reminded:

- *Positive effects*:
  - provides to the youths' better job opportunities, which would have not been possible in the country of origin. Also, as the youths are leaving, the domestic pressure related to excessive labour supply is diminished;

- contributes to increasing the accomplishment possibilities of young women and to strengthening the gender equity norms;
- avoiding marriages at a young age for girls as they leave for studies or for working abroad;
- the remittances flow can contribute to economic growth and poverty diminishment in the countries of origin and can stimulate investments in human capital;
- the Diaspora can be a beneficial source for technology, investments and capital transfer for the countries of origin;
- the physical or "virtual" return of skilled workers contributes to increasing the intellectual level of the human capital in the countries of origin, to competences transfer.

➢ *Negative effects*:
- loss of highly-skilled workers and diminishment in the quality of basic services;
- decline of economic growth and labour productivity by diminishment of the highly-skilled labour force stock;
- public investments in education are lower, and the parents' absence can increase the vulnerability of the young ones left behind;
- the teens remaining at home alone as result of parents' leave for work abroad must assume responsibilities which were before assumed by their parents. This fact can lead to decreases in the educational performance or even to school abandon;
- remittances correlated with the total or partial absence of parents increase the probability of criminal behaviour among youngsters left in the country of origin;
- migration can expose young individuals, in particular young women to higher risks of abuse, discrimination and exploitation.

2.1. Economic, social and demographic effects of youths' migration in Romania

With respect to international migration, Romania turned both into country of origin, and country of destination, yet the statutes is of *net emigration* country. Also, the numbers increased for migrating individuals transiting the national territory. The movements at the level of international labour force flows create distortions on the domestic labour market from Romania (structure, specialisation, segmentation), imbalances in the

demographic structure with economic implications (the development of macroeconomic indicators, fiscal effects, remittances) and on the social security system.

In particular the migration of young, working age, population leads to a crisis situation both on the labour market and on the social insurances and services market, respectively by exercising much stronger pressure on the employed population on Romania's labour market, and the changes in the structure on age groups, corroborated with a decreasing fertility rate lead to continuing demographic ageing.

The analysis of statistical data [1]-[2]- [11] about the emigration of young individuals from Romania highlights the fact that more than half from the number of persons who emigrated are young individuals with ages between 15 and 34 years of age (Figure 4).

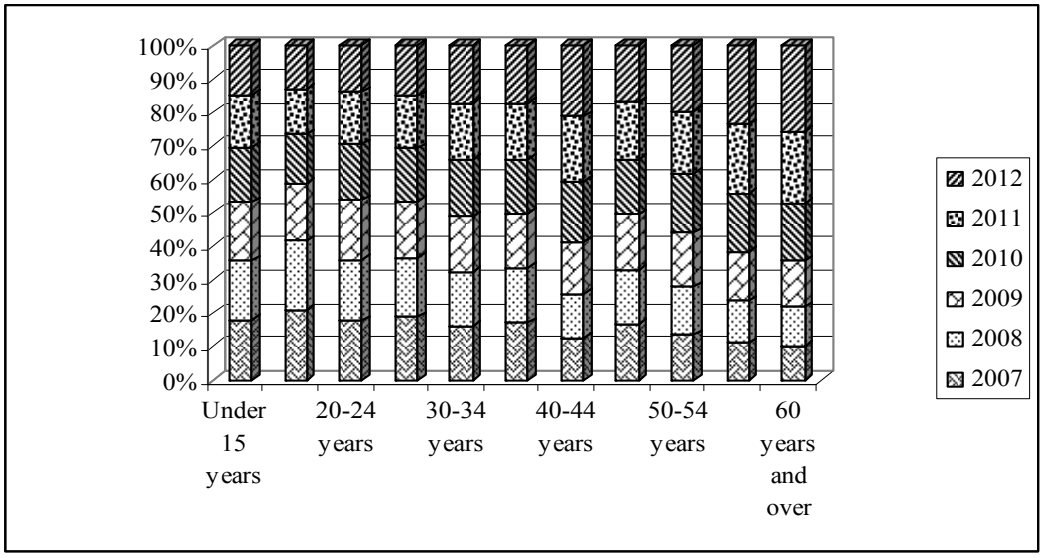


Figure 4. Evolution of emigrants on age groups.

Data source: Romania's Statistical Yearbook, 2013, Table 2.26

The abolishment, as of 2004, of the visa regime and Romania's accession to the EU in 2007 had as outcome the enablement of the free movement of Romanian citizens in the other countries within the EU area. The external mobility of individuals from Romania was emphasised in the period 2004-2008, and the main reason was the intention to work. The individuals that left for abroad (irrespective of the period – under or over 12 months) were about 2.5 times more in the year 2008 as compared with 2004. The characteristic of the Romanians is the long-term international

mobility, 12 months and over. Still, during the last years, when the effects of the economic crisis increased markedly, a trend is highlighted of diminishing the frequency of migration abroad for short-term (6 to 12 months), as compared to the one for long-term (12 months and over). Thus, the weight of those who migrated for work abroad for a period of 6 to 12 months was of 96.7% in the year 2012, against 97.8% for those migrated abroad for a period of 12 months and over. If migration abroad for studies for a period of 6 to 12 months registered a decreasing trend (from 2.7 in 2008 to almost half, respectively 1.3% in 2012), the migration for 12 months and over had an almost constant development (0.4%).

The migration of youths for studies, both for those with higher education and of those with secondary or lower education (Figure 5) can be justified, partially, by the economic conjecture associated to the incomes of the households and to the specific migration policy after 2007 [6].

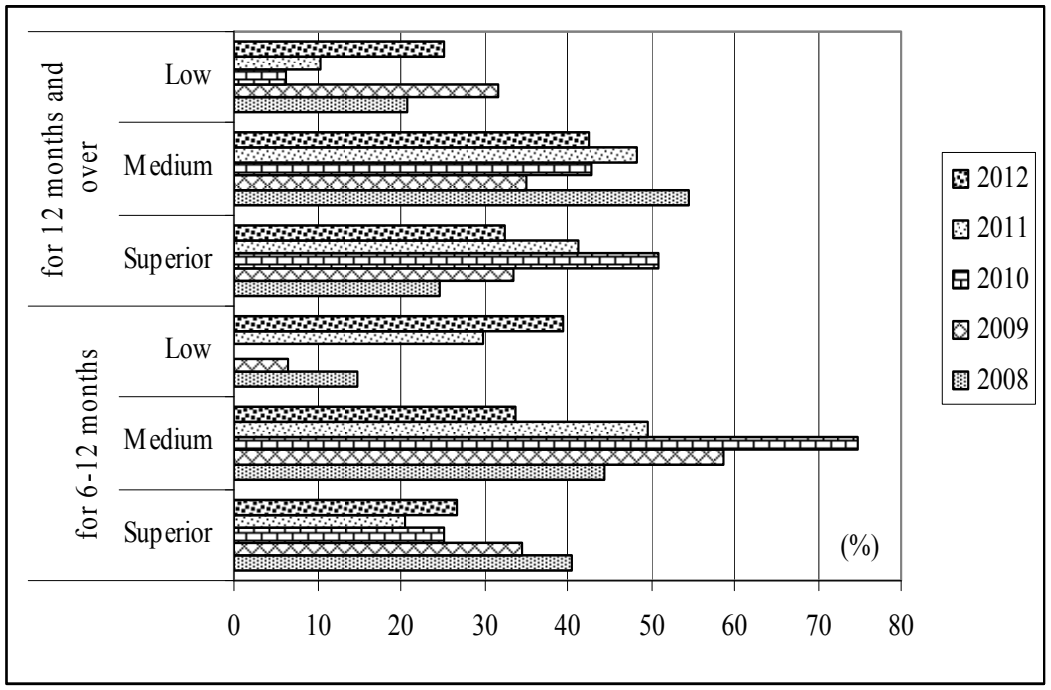


Figure 5. Structure of population migrated abroad for studies, on educational levels during the period 2008-2012.

Data source: Estimating the impact of free movement of Romanian workers on EU territory, from 01.01.2014; realities and trends from an economic employment and social perspective, at national and European level, European Institute of Romania, Strategy and Policy Studies – Spos 2013 Study No. 3

The youths migrating for studies are a particular category of migrants. Despite the positive and important role they can have within the Romanian society, the students returning into the country, after being trained in universities abroad face several difficulties in the reintegration process, from the cultural shock felt after contact and life in societies with other economic and social standards, to the issues related to the lacking attractiveness of the jobs in terms of wages and working conditions provided by employers.

Irrespective if temporary or permanent in nature, the brain drain phenomenon is increasingly an integral component of contemporary life and implicitly, also for Romania. Depending on the perspective, the brain drain phenomenon can represent an advantage or a disadvantage for the country of origin. On one hand, economic gains could be considered that can be obtained by the emigrants and the society they originate from and, on the other hand, the losses triggered by the decrease in the progress of the country of origin.

Among the most important negative consequences that this phenomenon can have on Romania, we could mention:

- lack of recovering the investments in the education and vocational training of emigrants, as result of the fact that young Romanians with higher-education, post-graduate education and doctor education are the most biased towards emigration;
- loss of contributions to the budget, represented by taxes and duties that these young individuals paid;
- speeding up the process of population ageing as result of the fact that young individuals with higher labour capacity – are most inclined to emigrate;
- the diminishment in the quality of education and research services, because this type of labour force is required to work in research, development and innovation fields;
- slowdown of the economic growth, because the migrating high-skilled young individuals trigger losses at economic level considering their importance in generating new ideas, attracting foreign direct investments, and increasing productivity.

With respect to the remittances flow to Romania, the statistical data indicate that these come to a share of about 81% from the EU area (significant remittances come from Italy, Spain, Hungary and Germany).

The estimates of international bodies show that for the year 2015 Romania remains the 4th country receiving remittances in the Eastern Europe and Central Asia area, with approximately 4 billion USD yearly (after Ukraine, Russia and Tajikistan). As weight in GDP, in the area, the highest share is still held by Moldova with a share of 24%. The strong decrease of the remittances' values during the crisis to about half in 2009 against 2008 was slowed down in the subsequent years, 2010-2013.

In general, these monetary transfers are used in Romania for consumption (current household expenditures), and investments in long-term use goods, stimulating thus the domestic demand of goods and services, but with predilection based on imports and not on domestic products, that have weaker competitiveness from the viewpoint of the quality and/or price. The money remitted protect the migrants' families from falling beyond the poverty threshold and have a modest contribution to local development by improving the condition of the houses, but not by investments in local infrastructure projects. The increase in consumption still contributes to a certain extent to the economic growth. The part dedicated to investments in production activities is very small also because of the insufficient market infrastructure development, especially in the rural areas from which most migrants originate. The remittances from working abroad are much more significant if also informal transfers are taken into account, preferred in particular by illegal migrants (for instance, at the level of the years 2005-2007, NBR considers that about 40% of the remittances entered Romania through informal channels, and the available data consider only bank transfers and the ones through Western Union, Money Gram and postal mandates (De Sousa, Duval L., et all, 2009).

The most important aspect from the *demographic* viewpoint is that the diminishment in total population by almost 789.984 thousand persons in the period 2007-2012 due to a negative dynamic in the natural increase was amplified by the migration flows that were negative for the entire period [5].

From the qualitative viewpoint, the negative migration increase is more "costly" to the society than the natural one, because the human capital investment (for instance in education) made up to the time of migration and the corresponding labour potential are transferred free of charge to the country of destination, which on long-term constitutes a hindrance for economic growth and sustainable human development because of the diminishment in active population, brain exodus etc.

Another demographic phenomenon related to emigration and with the same negative effects on long- and very long-term is represented by the migration of the female population at fertile age. The loss of human potential is higher in the case of women [13]-[15]. The younger they are, the more they can have several children, but these children are born and/or brought up abroad. Both in the case of temporary migration, but also in the one of definitive migration, the number of migrant women exceeded the number of male migrants (Figure 6).

The demographic forecasts for Romania show that up to the year 2030, a drastic population decrease shall take place. In the regions South-Muntenia (of about 425000 inhabitants) and in South-West Oltenia (of about 400000 inhabitants) the decreases are due to the high mortality, and in the North-East and South-West Oltenia regions due to migration. Lower decreases are expected in the regions Bucharest-Ilfov and West where the migration flows are stabilised, while the natural increase in the regions North-East and South-West shall be annulled by the negative migration flows [13].

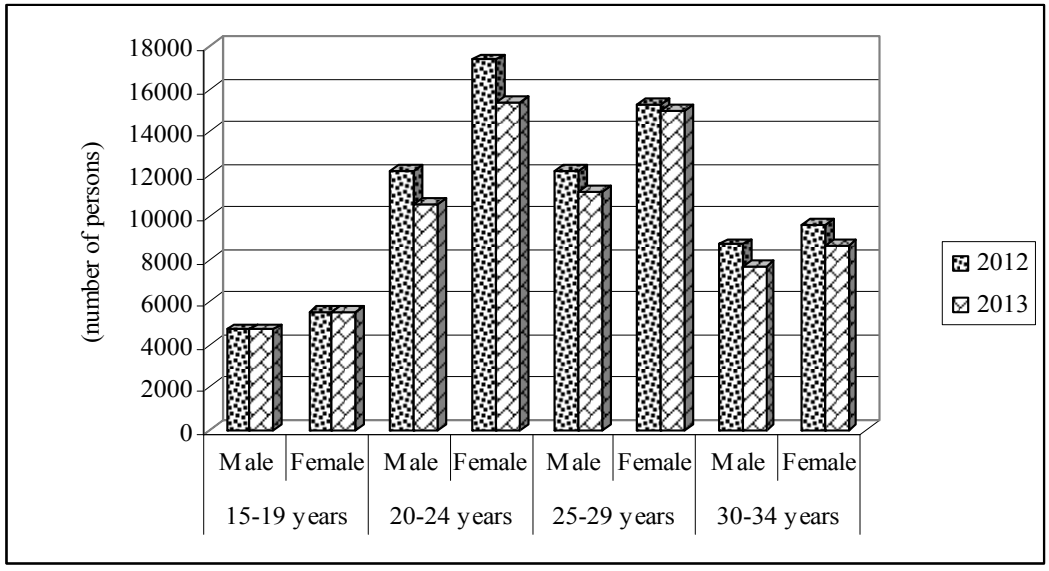


Figure 6. Evolution of temporary migrants on age groups and genders.

Data source: TEMPO-omline time series, National Institute of statistics, www.insse.ro

Also, the demographic forecasts indicate that until 2030 the number of young individuals shall diminish for all regions by 26-40%, and until 2050 the decrease shall be of 44-63% (higher decreases being registered in the regions South-West Oltenia and South-East). The age group 15 to 24 years shall decrease by 2050 to 1.3 million persons [13]. On the background of *decreasing numbers of young individuals*, the weight of adult population shall decrease considerably in particular after 2030, reaching 58%.

3. Conclusions

Globalisation triggers increased fluidity of territorial movements, new migration behaviours either for studies and/or work among young individuals, lending an unprecedented dynamic to the changes, monetary and competence transfers, to the convergence of human development provided that the benefits of these processes, in their turn, turn "global" for all involved actors.

Transnational flows of young individuals represent the main engine of development. From this perspective, migrants are perceived as change agents that contribute to socio-economic development by the transfer of financial and human resources to the communities of origin. The young migrants accumulate new knowledge in the countries of destination, have access to new technologies and transfer them back home during their periodic returns. Transnational social networks developed by migrants that connect countries of destination to the one of origin facilitate international business to the benefit of the regions from where they migrate.

In the country of origin, the young individuals' migration can lead to attenuating the imbalances on the labour force market by diminishing unemployment and increasing wages, but at the same time can more heavily emphasise the imbalances, either directly, or by triggering effects (lack of contributions to the state budget, migration of already employed, with imbalances and creating/deepening structural deficits). Also, new growth factors emerge such as: transfer of mobile workers' incomes, improvement of the training and knowledge level of those who return, and a new behavioural model at the workplace. In the country of destination, emigration contributes to increasing the human resources reserves thus leading to capital increase and slowing down wage increases.

Global estimates of the dimension and structure of migration flows for young individuals allow to the decision factors to adopt policies based on data that would maximise the positive effects of young individuals' migration and minimise the negative effects on families and communities both in the countries of origin and in the ones of destination.

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METROPOLITAN IDENTITY IN THE STRATEGIC MANAGEMENT OF CITIES DEVELOPMENT IN POLAND

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Abstract. *The metropolisation processes strongly influence the nature of managing the territorial units' development. Thus setting the strategic targets and their effective implementation foster a permanent cooperation between many entities. This kind of interactive and partner co-governance requires an active involvement of the representatives of local territorial self-government units and other stakeholders in the development of an appropriate organizational culture, common to the metropolis and its functional area. The aim of the article is to present the concept of the metropolitan identity as a new type of collective identification, which has a strategic importance in planning and managing the cities development. The study was based on contemporary strategic management conceptions, especially in the field of organizational culture and identity, as well as development management. The theoretical considerations have been backed up by an analysis of the strategic documents of the city of Poznań and Poznań Agglomeration.*

Keywords: *strategic management, local government, metropolitan identity*

1. Introduction

The ongoing process of metropolisation affects not only the biggest cities, but also the territorial self-government units surrounding them. The changes mostly concern the strategic development management as they require permanent cooperation of local governments, citizens, as well as cultural, economic and civic institutions that reaches beyond administrative borders. Therefore, it is important for them to develop an appropriate organizational culture, common to the metropolis and its functional area.

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The aim of the article is to present the concept of the metropolitan identity as a new type of collective identification, which has a strategic importance in planning and managing the cities development.

The study was based on contemporary strategic management conceptions, especially in the field of organizational culture and identity, as well as development management. The theoretical considerations have been backed up by an analysis of the strategic documents of the city of Poznan and Poznan Agglomeration.

2. Strategic development management in the functioning of territorial self-government units

The idea of strategic management refers to problem solving regardless of the nature of the difficulties that the organization faces. In general, strategic management is a process of identifying and implementing strategies in the organization, as well as defining and redefining the strategy in response to changes in the environment or with the intent to advance or even induce such changes [1, pp. 29]. Its main elements (and thus objectives) can be defined as [2, pp. 19]:

- strategic planning – establishing overall strategic goals and objectives, selecting appropriate policies for the acquisition and distribution of resources and ensuring a basis for turning policies into action commitments,
- resource management – determining the resources to meet identified goals and objectives, establishing the organizational processes, procedures and operations necessary to fulfill the strategic plan, as well as allocating the resources in accordance with strategic priorities,
- control and evaluation – scheduling programs from the point of commitment to completion, exercising control by anticipating and reacting to deviations between predicted and actual performance, monitoring activities to determine their reasonability.

Therefore strategic management reflects the organizations desire to achieve success through integrating different approaches and knowledge in various fields.

Yet, the specificity of the public sector, in which organizations are functioning in order to pursue the public interest through providing public

goods and services, enforces the extension of the public strategic management concept with additional characteristics [3, pp. 281-294]:

- responding to changes in policy requirements arising from the increasing complexity of the external environment
- focusing on the problems caused by the imperfections of the market mechanisms,
- embracing a very wide range of activities (solving problems at all levels of management),
- preference of tasks implementation through programs and projects undertaking,
- focusing on the development of programs for the realization of future demand for public goods and services (as specified in the development scenarios),
- taking into account the qualitative aspects of organizations functioning,
- the desire to support activities of other stakeholders.

These features result from the belief that it is impossible to design, implement and evaluate strategic objectives in the public sector based solely on economic criteria.

The territorial self-government units (TSU), which are considered the most basic public organizations under Polish administrative conditions, consist of: society, territorial space and local government authorities. The main objective of TSU's functioning is to provide goods and services to the governed community, functioning not only as an initiator, controller and producer of these services, but also as a provider of the economic profitability of such actions [4, pp. 161]. Therefore the strategic management in territorial self-government units is multifaceted – consists of space and people, who not only govern themselves, but also are interconnected through various social and economic networks. It's specificity results from [1, pp. 32]:

- TSUs actions in the public sphere are regulated by administrative law instead of the ownership law,
- the source of power of the local authorities derives from public trust (local governments are formed in democratic elections),
- TSU's are public life institutions and cannot be assessed only on the basis of rational and measurable economic quantities,
- the costs of public services are only subjectively and partially related to their amount and quality,

- the measure of the effects of strategic management is the common good of a variety of stakeholders, which manifests itself in certain distance from the investments and actions taken.

The functioning of TSUs is associated with the exercise of a wide range of issues and problems, which are key not only on the local level, but also from the whole country's point of view. The range of tasks includes i.a. spatial order, environment protection, supplying water and sewage infrastructure and electricity, healthcare, public education and culture.

Thus the strategic management in territorial self-government units can be defined as a future-oriented process of planning and selecting development goals, implementing the adopted tasks, as well as their monitoring and controlling [1, pp. 32]. Its main characteristics are [5, pp. 103]:

- complexity in the approach to development problems (perceiving the economic, social, spatial, ecological and cultural spheres as interdependent),
- efficient use of endogenous growth factors,
- treating a TSU as part of the environment,
- orientation for the future (on perspective targets),
- orientation for outcomes (achieving developmental goals),
- adherence to the principle of rational management,
- gradual introduction of sustainable development rules.

The most common instruments of strategic management in territorial self-government units are [6, pp. 46]: development strategies, operational plans for the strategies, the monitoring systems for both these documents and strategy actualizations.

One of the most important aspects of the functioning of the local governments is managing the territorial growth. It does not however restrain only to providing goods and services for the citizens, but should be understood as a commitment of local authorities to ensure the best possible standard of living for the inhabitants of the local community. Therefore, territorial development management can be defined as managing the subsystems of a certain territory in order to achieve the determined objectives [7, pp. 39]. The subject of this management is the community that resides on a certain territory, which acts through public authorities, public administration and other institutions representing it.

The classical strategic development management approach perceives the territorial self-government units as territorial organizations. This type of organizations need to fulfill three conditions [8, pp. 22]:

- spatial condition – the primary area of territorial organization's activity is a unit of territorial division, created in order to perform public administration,
- social condition – the people forming the territorial organization are a community of citizens inhabiting a defined territory,
- legal-economic management condition – the basis of the territorial community actions is the relations structure that arises out of legal acts and establishes the system of internal and external development and functioning conditions.

Even though the core of these assumptions had not changed, the processes of globalization and metropolisation have seriously affected the nature of strategic development management, making it a significant challenge for the territorial self-government units – not only the big cities, but also the smaller units surrounding them.

3. Metropolisation and its consequences for the strategic development management – towards a metropolitan identity

The term metropolisation refers to the process of forming a new type of spatial structure, i.e. the city that obtains an advantage over other units in the region and builds its importance in the international dimension [9, p. 10]. It is thus connected with development and involves focusing the economic, financial, scientific, authority, media and cultural institutions potential, as well as the main functions in managing the economy, innovation and public services. The process results in formatting a metropolis (core city) that in turn generate the metropolitan areas, which exceed the administrative boundaries.

The term metropolis refers to large urban centers with a high level of services and infrastructure, as well as innovativeness in all core areas of their functioning [9, p. 13]. The most important criteria that define the city as a metropolis also include: the uniqueness and specificity of a place (its historical significance and architectural and urban qualities) and the presence of strong centripetal integration links with an extensive suburban area – the metropolitan area.

The metropolises are thus urban centers and their functional areas that are at least the national centers for economic governance. Apart from their economic potential, they should also offer higher-order functions and public services and perform symbolic functions. The other significant qualities of metropolises are also: tourist attractiveness, presence of highest standard scientific (universities, research centers) and technological institutions. Metropolitan functions include also the external and internal transport availability of the city and the functional area.

The metropolisation process directly affects the nature of the territorial organization, causing a change in its characteristics [10, p. 60]. The functions performed by the core city are determined functionally and spatially and can exceed the administrative borders of territorial self-government units. Therefore the community that creates the territorial organization is a group of people connected rather by common socio-economic interests than just certain rights and obligations. As a result, the key causative mechanisms in the functioning of these new metropolitan organizations are partnership and voluntary cooperation.

Thus, the effective implementation of strategic public policies requires a sustained cooperation of many territorial self-government units. This means that the territorial management should have the nature of an interactive co-governance, in which the success depends on the capacity of the core city to trigger the abilities of the members of the social system to actively adapt and create new solutions through a process of social communication, negotiation and communication [11, p. 98]. The essential elements of this concept are: stakeholder engagement, openness, transparency, equality, non-discrimination in the use of public services and accountability of decision-makers.

Such an approach reflects the changes that affect the nature of strategic regional development management, which raises the importance of cooperation within the multi-level governance system. Apart from that, the new paradigm of territorial development [7, pp. 72-74]:

- takes into account the territorial consequences of new socio-economic challenges (such as globalization and metropolisation),
- focuses on the endogenous development potentials of a territory, not on the exogenous support mechanisms,
- emphasizes the strategic approach by concentrating on key priorities and their efficient management,

- promotes the learning process through prospective evaluation of the actual impacts of the policies,
- recognizes the importance of real and virtual mobility growth in the society.

Therefore the participation of territorial self-government units that are members of the metropolis is crucial for the effective strategic planning, making decisions, managing resources, as well as controlling and evaluating the development policies, while working towards reducing and mitigating the disputes and the most efficient use of the potentials of these entities. The changes caused by the progressive metropolisation and the new paradigm of territorial development enforce the necessity of change in the way of local communities functioning. These changes involve the transformation of the territorial organization's culture (the organizational culture of the core city and its functional area).

The organizational culture is therefore understood as an internal variable, i.e. an element (subsystem) of the territorial organization that can be effectively managed. Its core is the organizational identity – 'a symbolic collective interpretation of the people who form the organization on what the organization is and what it should be like' [12, p. 17]. It is therefore a consensus on: values, organizational culture, operating philosophy, orientation, mission and vision, as well as organization membership that meet the following criteria [12, p. 17]:

- the criterion for determination of organization's key features – the organizational identity reflects its essence, the basic 'existential' issues on which the consensus of its member is based,
- the criterion for diversity ascertaining – the organizational identity is defined by a sense of separateness of the organization's members, they identify with the organization and define its boundaries and inclusion or exclusion criteria,
- the criterion of continuity over time – the identity is a result of temporal continuation and the organization is integrated through legal and management conventions, which in turn are supported by the beliefs of its members as well as other stakeholders opinion about the continuity of the organizations existence, despite the ongoing changes.

Organizational identity consists of cultural patterns and values, basic assumptions, social and organizational norms, as well as ways of communication (myths, narratives), symbols and rituals.

The ongoing processes of globalization and metropolisation contribute to changes that enforce the necessity of shaping the organizational identity that enables efficient and effective territorial management in metropolises. This emerging new type of collective identity can be called the metropolitan identity, which can only be achieved in the case of stimulating the ongoing cultural change. The process of assimilation of the amended culture consists of the following stages [13, p. 74]:

- extraction of the current norms and standards on the surface,
- the determination of new development directions,
- establishment of new cultural norms,
- identification of the cultural gap,
- elimination of the cultural gap.

The actions aimed at setting the new directions of development need to begin as soon as possible. Otherwise, the functioning of metropolis can be disrupted by the negative effects of the lack of cultural change such as [14, pp. 30-44]:

- limiting the possibility of implementing new strategies – the values existing in the cultures of local communities may quarrel with the assumptions of new public policies and hamper the cooperation in shaping the planning documents,
- causing problems in the situation of alliances and merging the entities – the inadequacy of local cultures may hinder the participation of territorial self-government units in the assumptions of the new paradigm of territorial management,
- the difficulties with the implementation of new forms of organization, new technologies and changes in the structure – changes of this type are essential for the proper functioning of the metropolitan centers,
- generation of intergroup conflicts in organizations,
- problems with the communication system – different cultural perspectives of specific communities prevent the convergence of perception,
- difficulties with secondary socialization of individuals that lead to the reduction of possibility of assimilation of new members,
- reduction in the effectiveness of cooperation.

The key to effective strategic development management in metropolises in the face of a new territorial development paradigm is therefore the establishment of cultural norms that are common to the societies that inhabit the metropolitan areas. The difficulty of this task results from the fact that the metropolitan identity depends largely on the norms and values shared by the communities of the territorial self-government units that are members of the metropolis. Thus, it is plausible to speak rather about metropolitan identities; however it is possible to identify several elements that can reflect the shared values that are relevant to all of the residents of the metropolitan areas:

- the functioning of a network civil society that reaches beyond its classically conceived administrative boundaries,
- taking into account the importance of real and virtual mobility of the community,
- the acceptance of the development of network forms to organize the economic, social and cultural activities,
- the belief in the necessity of an active participation of the representatives of the metropolitan community in shaping the public policies of the metropolitan areas, which leads to an increase in the effectiveness of public interventions and directing them to the real social and economic needs,
- a multi-level and interactive metropolis management performed through territorial self-government unions and associations, as well as various intersectoral partnerships – joint negotiating, monitoring and coordination of public policies with the use of endogenous potential of a certain functional area.

Thus the metropolitan identity may not have the same emotive character as the national or regional identities do. Its main values are rather: the respect for human rights, the cult of real and virtual mobility, social trust and a broad participation of social actors in management. However, creating the connections between the TSU's communities that are part of the metropolis will also require the use of traditional norms and the existing proceedings patterns.

The metropolitan identity is thus a crucial issue in the strategic development management of metropolises, as setting the strategic targets and their effective implementation require a permanent cooperation between many entities, including not only the authorities, but also the representatives of economic, cultural and social actors and institutions.

Therefore expanding and sustaining the organizational culture based on participation and cooperation becomes a strategic target itself. One of the first metropolises in Poland that recognized the importance of developing the metropolitan identity is the Poznan Agglomeration.

3. The metropolitan identity in strategic development management of the Poznań Agglomeration

The Poznan Agglomeration consists of the core city of Poznan and twenty one communes, including: Buk, Czerwonak, Dopiewo, Kleszczewo, Komorniki, Kostrzyn, Kórnik, Luboń, Mosina, Murowana Goślina, Oborniki, Pobiedziska, Puszczykowo, Rokietnica, Skoki, Stęszew, Suchy Las, Swarzędz, Szamotuły, Śrem and Tarnowo Podgórne (Figure 1). As of 2014, the area covers 2 884 km^2 and is inhabited by 1 009 216 people [15]. In 2011 the territorial self-government units that are the members of agglomeration signed 'The Poznan Agglomeration Development Strategy – Poznan Metropolis 2020'.



Figure 1. The Poznań Agglomeration.

Source: Strategia Rozwoju Aglomeracji Poznańskiej – Metropolia Poznań 2020, Centrum Badań Metropolitalnych, Poznań 2011, p. 145.

The document reflects the participatory and multi-level character of the metropolis management – it was created through a cooperation of local governments, universities, as well as public, social and economic organizations and consulted with the societies of each commune.

The strategic targets and actions planned are aimed at ensuring a greater territorial and functional cohesion of the agglomeration, through the improvement of the spatial order, state of the natural environment economic growth, infrastructure development, as well as the integration of public transport and improvement of social services. The targets are supplemented by a broad strategic axis related to creating the forms of cooperation and effective management based on the participation of territorial self-government units and other public and commercial institutions. One of the core programs in this vision of metropolitan management refers directly to the metropolitan identity.

The 'Metropolitan identity' strategic target aims at shaping, developing and promoting the identification with Poznan metropolis as a common place to live, work, rest and use of service beyond administrative boundaries [16, pp. 128]. This new kind of identity is defined as 'agglomerative/metropolitan thinking' that supplements and changes the local identifications and is an important factor fostering the development of the region. It is also understood as an instrument of spatial and functional integration, affecting not only local governments and members of communes societies, but also companies and institutions that will use the metropolis idea to promote and identify territorially with the Poznań Agglomeration. The proposed actions to develop the metropolitan identity are [16, pp. 129]:

- dissemination of the metropolis idea in primary, secondary and higher education – through lessons about agglomeration on subjects such as: civics, geography, history or economy,
- creation and dissemination of educational materials on the metropolis, its history, environment, infrastructure, sport and cultural events, as well as the actions of local governments and civic organizations,
- the activity of local and regional media in the field of creating the metropolitan idea, climate of trust and the feeling of identification with the Agglomeration,
- the use of existing and organization of new events, festivals covering the whole metropolitan area,

- supporting the social initiatives, associations and foundations, NGO's that promote metropolitan values and actions,
- creation of 'the metropolitan company' brand – supporting the companies that promote metropolitan actions, organization of a "Metropolis-friendly company' competition,
- metropolitan social barometer – regular monitoring of public opinion on topics related to metropolitan awareness and identification.

It is therefore plausible to claim that the territorial self-government units that form the Poznan metropolis are aware of the functional character of the metropolitan identity and recognize the need for participation and cooperation in the globalization era, which fosters virtual and real mobility.

Moreover – although it is not stated directly in the description of the metropolitan identity strategic target – the document states also the emotive core of this new type of identification. The common values and symbols of the Poznan Agglomeration are [16, p. 30]:

- the historic heritage of the Poland state and Piast dynasty,
- the memory of organic work and opposition against germanisation (called "the longest war in modern Europe"),
- the Greater Poland region thriftiness, hospitality, diligence, reliability and a passion of order,
- cultural ties, including dialect, manners and regional cuisine.

These assumptions are further supplemented with [16, p. 35]: liberalism (political attitudes are closer to the economic liberalism, which is reflected in the parliamentary election results), 'bourgeois character' (conservative attitude, mostly moral conservatism) and 'wealth' (a relatively higher standard of living compared to other cities, which manifests itself i.e. one of the highest purchasing power of the population in Poland).

Most of the characteristics mentioned in the strategy are strictly related to the historical inhabitants of the Poznan Metropolis. Therefore they may not have the binding value for the newcomers from other parts of Poland or foreign countries, whose settlement is a natural process in the globalization and metropolisation context. Their assimilation to 'agglomerative thinking' will require finding much more universal values that could bind the metropolis. Yet, the decision to consider the metropolitan identity as a strategic target in the development management

of Polish metropolises was unique and innovative, not to mention necessary for the efficient growth.

Nevertheless, 'The Poznan Agglomeration Development Strategy – Poznan Metropolis 2020' is a document of a higher order, which provisions must be reflected in the development strategies of the territorial self-government units that are members of the metropolis. Unfortunately, the depth analysis of these documents shows that most of the local strategies (13 out of 21) do not even mention the metropolitan identity, either directly or indirectly. This tendency is disturbing, as most of these documents were adopted after the agglomeration strategy was passed.

Among the others, three main tendencies can be distinguished. First, it is possible to distinguish the documents that stand almost in opposition to the provisions of the agglomeration strategy. Some of the territorial self-government units state directly that their own identity and individualism is much more important than the metropolitan identity:

- *It is obvious that the Śrem municipality doesn't have to be interested in participating in the implementation of all of the projects, but should choose only those projects that will serve the satisfaction of its own citizens (...)*[17]
- *At the same time, the location in the metropolis is not just a passive submission to the stronger tendencies, but it is also a conscious and active formation of the trends, while maintaining the communes own identity and individuality (...)* [18]

Other communes' commitment to the metropolitan idea seems to be based strictly on the expectation of benefits:

- *The land of Szamotuły is a region of great folklore traditions, as well as rich culture and history. However, maintaining this kind of activity requires considerable organizational and financial resources (...)* [19]

Finally, there is a group of territorial self-government units that refer directly to the metropolis as a vital part of their development plans and that want to play a crucial role in the development processes: Mosina and Swarzędz:

- *The Mosina commune 2020+ in the metropolitan area of Poznań is a centre of small, dynamically operating service companies that is well communicated with the city and the neighboring municipalities and provides services for the population in the internal consumer market and the business of Poznań, as well as the southern part of agglomeration (...). Good railway and road communication allows an easy access to the labor market and high-order services in Poznań and the southern part of agglomeration for the local inhabitants (...)* [20].

Therefore, only Poznań, as the core city, refers directly to the idea of metropolitan identity in its development strategy – the creation of Poznań

Metropolis is one of the four strategic targets set in the document. It should be achieved through actions aiming at increasing both the international importance of the city in the network of European metropolises and the raise of cohesion through functional and spatial integration of the city and agglomeration [21, p. 133]. The creation of metropolitan awareness and identity is supposed to include the development and promotion of identification of the Poznań citizens with the metropolis as a common place to live, work and recreate, as well as regular surveys on the metropolitan awareness. None of the provisions suggest the values and symbols that could be common for the core city and the functional area. Moreover, the 'Cultural Poznań' strategic programme focuses mainly on increasing the city's cultural offer attractiveness, the cultural competences of the inhabitants and creating an international brand for Poznań [21, pp. 169-170]. Thus, it is plausible to claim that even the core city focuses mostly on developing its own identity, perceiving it as the main component of the metropolitan idea. Such actions may be considered oppressive by the territorial self-government units that are part of the metropolis, as the hidden rivalry may hinder the participation in the multi-level strategic development management.

4. Conclusions

The process of metropolisation enforces the cooperation and participation of various territorial self-government units in the strategic development management. The common potentials and problems emerging from the functional character of the metropolis can only be effectively used through multi-level interactive approach, in which all local units are perceived as partners. Thus, it is essential for the metropolitan strategic development management to create a proper organizational culture that would be inclusive and conciliate the values, symbols and rituals of all the communes that are affected by the core city. Therefore, the creation of the metropolitan identity becomes one of the most important strategic targets, which achievement is crucial for the effective development management of the metropolis.

The Poznan Agglomeration was one of the first associations of the municipalities to adopt a metropolis development strategy that would refer

to the idea of metropolitan identity. Yet, as the in depth-research of the strategic documents of each of the territorial self-government units reveals that most of the provisions of 'The Poznan Agglomeration Development Strategy – Poznan Metropolis 2020' have only a declarative character. Most of the local governments consider the cooperation rather as a promise of long-term profit than as a possibility to create real mechanisms fostering development. The provisions on working on the metropolitan identity are contradicted by the internal focus on developing the local values and culture of each commune.

The Poznan metropolis strategy can therefore be perceived as an impulse for a shift in the strategic development management of cities in Poland. The document itself creates the possibilities to cooperate and expand the idea of metropolitan identity. It is necessary however to enforce the cohesion of the provisions in the metropolis strategy and the lower level strategies of local communities. Without such changes, the metropolitan identity will not be a real identity and will not be able to provide the bonds, values and rituals that could foster the effectiveness of the strategic development management.

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"YOUNG FAMILY" AS THE SUBJECT OF POLISH SOCIAL POLICY. FICTION OR REAL SUPPORT?

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Abstract. *Social policy is designed to study the changes that are taking place in the social structure under the influence of purposeful activities of public authorities and NGOs. It should also indicate directions and ways of solving contemporary social problems and evaluate the results. In today's world one of the major problems is the stability and proper functioning of the family, especially a young family. This is due to the fact that all the dysfunctions in this area involve long-term adverse socio-economic impacts on society as a whole. The purpose of this article is to analyze and evaluate the Polish activities of public authorities to ensure the development and support for young families in particular in the fields of employment, social security, housing and institutional care for children.*

Keywords: *social policy, young family, government, public finances, public support.*

1. Introduction

The development of civilization entails dynamic changes in the functioning of societies that also affect the functioning of the family. There is changing family model, the roles of individual members and their needs. For example, today we do not think about it, or women in general should work but how the work should be organized [8]. The situation of women in the labor market, however, is worse than men, which is largely conditioned by gender roles in society. As a result, problems arise, inter alia, to the decision on the number of children, reconciling work and family life, as well as the desire to ensure an adequate level of family wealth. These problems pose a challenge not only for families, but public authorities – almost all organizational levels. Because the family is the bridge between

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the individual and society, issues that touch and dynamics of pathological phenomena moves to the wider community [11]. Ultimately, the family dysfunctions cause consequences for social life and economic each country, including, inter alia, the proper functioning of the labor market. From the point of view of the public authorities seems to be an important to pursue a policy oriented not for a "stiff" regulating of functioning the family, but her support by providing appropriate conditions for its existence. The purpose of this paper is to review the solutions used in Poland in the area of family policy and evaluation from the perspective of contemporary social challenges.

2. Young family as a matter of social policy

In contemporary world one of the major problems is the stability and proper functioning of the family, especially the young, from which to a large extent depends on each country's demographic future. The family, which is one of the categories of social policy is understood as "two or more people that are related as husband and wife, living together partners (cohabitants) – people of the opposite sex, or as parent and child" [5].This means that the term family includes both a pair without children or a pair with one or more children as a single parent with a child or children. Against this background, a young family is the family, "in which the spouses (cohabitants) are at most at the age: female – under 30 years, and the man – less than 35 years" [5]. An important determinant of young families is therefore primarily their age, but can also indicate other characteristics, including [3]:

- lack of economic independence, which often leads to prolonged depending on parents' generation, which also brings negative consequences in terms of socialization and family education,
- preference for partnership in the relations between men and women, leading to the prevalence of egalitarian marriage, as well as
- a significant reduction of differences in the level of enrollment rate between men and women, which affects the change earlier (traditional) models marital and parental roles.

The functioning of young families in today's socio-economic realities facing many challenges. Analyzing the demographic trends that are long-term and unchanging, can be identified a number of important and closely related elements. The starting point is here characteristic, especially for Europe's aging population, understood as an increase in the proportion of

the elderly population. Among the many reasons for this state of affairs, in addition to extending the average life expectancy, there may be mentioned, inter alia, the functioning of young families, their numbers and their fertility. Young people postpone the moment of starting a family, which is often associated with uncertain professional situation, the longer the period of study, the lack of financial stability, as well as a reluctance to take any more durable commitments. The appearance of the child in the family is also postponed because women give birth in an increasingly later age, with the result that there are fewer and fewer. Analyzing the Polish example – based on data from the Central Statistical Office (GUS) – we can say that now children who are less than 6 million, account for about 15% of the population, the number of them is still falling. For comparison – in the middle of 80-ies of the twentieth century, this share was about 25% [20]. On the other hand, many families give up at all with having children, which is both the result of a conscious decision (model DINKS – double income no kids) and lower fertility [10]. Studies in Polish woman procreation attitudes showed that the reasons for the resignation or defer the decision to have children, in addition to concerns (mainly women) from the loss of job, the lack of support from the public authorities.

Contemporary social policy in its practical dimension aims to provide social security to citizens, while mobilizing people to work, as well as activating their entrepreneurship and sense of responsibility for their own future. This means the development of appropriate – the economic realities of data – terms and conditions of existence of the population [7]. On the other hand, social policy is designed to study the changes that are taking place in the social structure under the influence of purposeful activities of public authorities and NGOs. It should also indicate directions and ways of solving contemporary social problems and evaluate the results.

The purpose of today's social policy is to create a pro-development social structure associated with the building of social capital. As a result, one of the key directions of this policy is the policy of the family. From the point of view of regulation and making power for the European Union social policy is left entirely to the discretion of Member States. Simultaneously, EU legislation supports the specific regulations concerning, inter alia, labor market policies, social cohesion and broader economic reforms. Records relating to the activities "about family" are provided both in the Lisbon Strategy, the Europe 2020 Strategy, as well as a number of Directives and Communiques relating to issues of maternity, parental leave, family protection, equal treatment and the employment of women and men or solidarity between generations. In the case of

referenced the Europe 2020 Strategy, in the area of social integration – including in the context of social equal opportunities – there is a referred about activation activities for families and children, especially in areas such as education and health care. On the other hand – from the point of view of the stability and competitiveness of the economy - there are demands for active labor market policies, including ensuring a balance between family life and work and the conditions for the presence of both parents in the labor market. It is closely related to, inter alia, the need to establish adequate forms of institutional care for children. Among the key challenges facing the modern family policy should be mentioned, thus primarily [4]:

- demographic challenges related to the already mentioned trends in the choice of the model of the family, age of starting a family, the fertility rate and an aging population,
- socio-economic challenges associated with the desire to increase the competitiveness of the economies of individual countries, including by ensuring the stability of the labor market, as well as combating poverty and other exclusions, and
- axiological challenges related to, inter alia, to the maintenance of a high-ranking family in the system of values.

From the point of view of social policy, you can specify both narrower and broader understanding of the policy. In a narrower sense, this policy covers essentially only those activities and instruments that are aimed directly at the family (immediate family policy). In terms of the broader scope of the policy is also extended and about other spheres of social life that cause consequences also for families (indirect family policies) [2]. Regardless of the approach is worth noting that today's family policy is taking more and more often – especially in the face of an aging society – the direction of pro population. In many countries it is a legal obligation, flowing from the Constitution. That is true in Poland, where the "marriage as a union between a woman and a man, the family, motherhood and parenthood are under the care and protection of the Republic of Poland" [6]. Apart from the usual instruments for the promotion of family procreative function (leave, benefits and cash assistance related to childbirth and raising children), as extremely important consider the action to be forming a "good climate" for the functioning of the family, especially the young. This is related to the provision of specific support, including such areas as employment, social security, housing and institutional childcare.

3. The activities of Polish public authorities to support young families

Public government policy, which is aimed at supporting the family uses both instruments as direct and indirect. To the first group consists of mainly financial benefits which include, inter alia, all sorts of benefits, family benefits, and other forms of financial aid. While the second group are widely understood public safety services functioning families and supporting the process of raising children, services in the area of health care, as well as activities in the field of housing. Population Census Data from 2011 show that more than half of households with multiple take a self-contained, which is not the elderly. It is probably the aspirations of young families to the kind of "independence" and reduces the impact of third parties. This trend is more noticeable in urban areas (53%) than in rural areas (40.4%) [5]. For young families, a significant obstacle in this area are mainly financial barriers.

The State responding to the housing problems of young families a few years ago – in 2006, introduced the "Family on its own" (Rodzina na swoim) program, which was intended for both couples and single parents. The program was designed to help in the purchase of their own homes to people without property. However, it was important that the aid for the loan installments was closely linked with the surface of the house or apartment – pays up to 50 m^2 for housing, up to 70 m^2 for the home. The apartment, however, could not be larger than 75 m^2, and the house of 140 m^2, and the maximum rate per meter apartment were separately determined in each province. The state financed and for ongoing contracts continue to finance (as the last call to the “Family on its own” program was completed in 2012), about half of the interest paid during the first eight years to repay the loan for its purchase. The program included both primary market and the secondary market. Banks participating in the program, a total of 181.563 granted preferential loans in the amount of 32.956.823 tys.PLN [19].

Currently in Poland there is a new program – Apartments for Young (MdM), which greatly differs from the above-presented. Firstly lets down payment financing only for those up to 35 years old, the first buyers own apartment in the primary market. Funding is varied, and so, for singles and childless couples is 10% of the index reflects the average cost of construction of housing in a given location, for individuals and families with at least one child – 15% Surcharge may be covered a maximum of 50 square meters, while the same apartment can not be larger than 75 square

meters, and the house of 100 m². In the case of families with at least three children limitations on the maximum surface were increased by an additional 10 square meters. In addition to the above mentioned benefits, additional support is provided for families using MdM, who within 5 years from purchase apartment number of children has increased by a third or more after the third child. Funding will be granted only once and will be 5% of the specified amount [15].

In practice, however, the new program is not able to use a large group of young people, even though they fulfilled certain conditions. It turned out that the young families often have difficulty in obtaining credit. In addition, high housing prices in the primary market often prevented the purchase of real estate. The State, in response to these problems started to introduce modifications. In March 2015 was adopted the project amendments to the law on state aid in the purchase of a first home for young people. As a result, a number of emerging problems is not possible to obtain a credit rating, it was decided that the loan agreement with the borrower will be able to proceed with any person, and not, as yet, only a person with a close family. In addition, by the MdM program will also be covered homes as a result of conversion or adaptation. However, if the borrower during the period of five years from the date of creation or transfer of ownership of the apartment, overpays all or part of the loan in the amount greater than the support granted, will have to pay part of the financing of own contribution. The current program does not provide for any penalties for early repayment [17]. The project also assumes that when in the family will be two children, funding will increase to 20%, for three and more of them, support will be increased to 30%. At the same time for families with at least three children will increase funding to the size of the property apartment of 50 m² to 65 m². For individuals and families with at least three children were abolished as a condition of "first home" and the age limit for parents.

Demographic changes represent a significant hazard at the same time a challenge for the social security system. This is mainly due to the backrest its parts on the so called generational pyramid, in which the younger generation – as the majority – provides funding to benefit the aging generation [9]. In the case of reverse trends is significantly threatened the solvency of the system, especially in the long term. From this point of view, therefore become necessary steps to ensure that in the future to reduce the quantitative differences between the generations. This requires specific actions aimed at increasing the fertility of modern

families, inter alia, by giving them certain conditions, including financial, especially in the first period of a child's life.

In recent years, the government in Poland repeatedly modified provisions concerning social security, and including provisions directly affecting young families. Before starting the analysis should be noted, however, that the considerations set out below are general in nature, since the majority of these solutions there are additional regulations, exceptions.

First the woman who during the course of the employment relationship became a mother, a woman should be and maternity leave of 20 weeks[2]. It is paid at 100% of base salary. Mother can interrupt the download allowance (generally after 14 weeks, and in special cases after 8 weeks), and the right to its use gets another guardian of the child. After using maternity parent has the right to take advantage of additional maternity leave. At present it amounts to six weeks at birth a child and to eight weeks while having two or more children at one birth. With this, an additional 100% paid maternity leave (under certain conditions) on an equal footing can be used by both father and mother, regardless of whether they work on time, order, or conduct business activities.

In 2013, in Poland was made a big change, and for people who work under an employment contract introduced a new, 26-week – regardless of the number of children born at one birth – (paid 60% of the base salary) parental leave. The leave can benefit both parents, even at the same time, the fact that the total length of leave and benefits enjoyed by both parents can not exceed 26 weeks. In addition, the father is also entitled to a 2-week paternity leave, possible to use in the first year of life. After the use of parental leave, both mother and father (depending on employment relationship) may benefit from free (36 months) parental leave until the child is 5 years. During this leave for parents from the state budget contributions are paid to the pension scheme from the base equal to the amount of the average monthly remuneration paid for the 12 months preceding the maternity leave. The base can not be higher than the amount of 60% of the projected average and may not be less than 75% of the minimum wage. Since 2016 it is planned to parents who are not employed and do not pay social security contributions for a year since the birth of the child to receive financial support in the amount of PLN 1000 per month, regardless of income per person in the family.

On the birth of a child state pays benefits tax-free income. Its receipt is subject to fulfillment of the income criterion. With the birth of a child is

[2] In the case of twins 31 weeks, and with the birth of another child at one time increases by two weeks – up to 37 weeks maximum.

entitled to a one-time grant from the State of PLN 1000 – the so-called "baby bonus". By 2013 baby bonus was paid to all citizens, but at the moment monthly income per family member does not exceed PLN 1922. Another condition for its receipt is the child's mother to remain under medical supervision no later than 10 weeks of gestation until birth. The introduction of this requirement was to motivate women to surrender as soon as possible medical care during pregnancy. Besides "baby bonus", to the childbirth allowance, in certain communes, by resolution, shall be paid a one-time allowance. The amount depends on the funds of the communes.

Apart from the benefits payable the childbirth grant state supports young parents through the payment of family allowances, which are the main element of the nature of direct family. Among the key features of these benefits it should be mentioned: income function (increase family income), compensatory function (compensate – at least partially – expenditure incurred in having children), the function of reducing disparities in living standards of different types of families, as well as stimulating functions (interacting specific social behavior – in this case, pro-family) [1]. In Poland those benefits mainly include: the family allowances and supplements to family allowance, care benefits such as attendance allowance, nursing allowance, caretaker's allowance and special allowance for the caregiver. It is important to emphasize that care benefits are awarded to people with a disability and their caretakers. Family allowance and allowances are awarded after fulfilling the income criterion, which in 2015 is PLN 574 per person in the family, or PLN 664 if a family member is a child with a disability. Benefits compared to other EU countries, are very low and, for example, monthly family allowance is 77 PLN for up to 5 years of age, 106 PLN for children between 5-18 years and 115 PLN for children aged 18-24.

In 2015, Poland changed the rules of the annual tax returns, which currently are more favorable for large families. Increased by 20% have the amount that may be deducted in the tax returns for the third and subsequent children. The tax credit was taken while parents having one child whose income was more than 56 thousand PLN per year per parent. At the moment, the family with a minimum two children can make a subtraction in the tax settlement, regardless of income.

For large families – having a minimum of three children, irrespective of the level of income in 2015, there introduced a system of discounts in the form of so-called "Card of big family". Possession of this card entitles parents – for life, and children up to 18 years of age or 25 years of age, when they take science, to discounts and allowances mainly from the

sphere of culture, recreation and communication. It is worth noting that the initiative to introduce the card comes from the same family, associated in the Association of Large Families "Three Plus", and the number of partners constantly increasing [18].

The problems of young families in Poland often also result from inability to take up employment (especially for women), which is a consequence of the deficiencies in institutional childcare. With the above difficulties, facing not only the Polish family, but the vast majority of countries belonging to the EU, a European Commission report published in 2013 shows that EU Member States will need to accelerate work to improve legislation on childcare facilities for the EU to reach the target of 75 per cent of employment by 2020. In 2002, the leaders of the EU member states agreed on the so-called "Barcelona objectives" in terms of childcare facilities, as well as being the basis for the formulation of EU and Member States' strategies for the reconciliation of work and private life. It was assumed that by 2010 places in nurseries or kindergartens should suffice for 33% of children under three years old and 90% of children aged from three years to school age. The realization of these objectives was to help women to combine motherhood with work. According to figures published by the European Commission shows that only eight countries achieved targets for both age groups. These include: Belgium, Denmark, Spain, France, the Netherlands, Sweden, Slovenia and the United Kingdom. Five other countries fulfilled one criterion. Poland, unfortunately, was not included in any of these groups, and in terms of the number of places for children under 3 years of age was in last place. It should also be noted that difficulties in accessing public institutional forms of care in Poland refers virtually all types of biological families.

Authorities in Poland, realizing the need to implement the "Barcelona objectives" and noting the problems of families due in part to deficiencies in institutional care of children, a few years ago began to perfect the system. Until 2011 in Poland Institutional Child up to 3 years was based only on the nurseries, which were subject to the Ministry of Health. Number of seats in institutions was insufficient, and demands against the entities wishing to set up this type of institution enormous. In 2011, came into force the Act on childcare up to 3 years [13]. In view of implementation of the Act, introduced in caretaking roles, educational and learning can take place in the nursery (subordinate to the Ministry of Labor and Social Policy), children's club, the daily supervisor and the nanny. Generally, nurseries and children's clubs differ greatly, and the most important differences include the time in which the children are in

institutions, the age at which they are received, the number of caretakers, the obligation to provide children with food, different housing conditions, whereby it should be noted, nurseries provide a fuller range of services.

In 2011, on the one hand to meet the needs of young couples, on the other, in order to limit the gray zone has been instituted nanny. Nanny as the private entity has custody of the children on the basis of the so-called "mobilizing agreement" signed between the parents and the nanny. It is characteristic that for the nanny social security contributions (with exceptions, and under certain conditions) is required to pay the Social Insurance Institution – contributions from the state budget or the child's parent.

Introduced in 2011 daily guardian institution, also had to help young families and facilitate entry or return to the labor market. Daily guardian is a person employed by the commune under a contract for services. The choice of caretakers in the local government units is done on the basis of open competition. From guardians are required to have the appropriate qualifications, training completion and disposal of the relevant conditions form of office space. Commune, however, may provide or equip the local to care for the caregiver.

For parents of children in kindergartens, in 2013 the government also introduced facilities. Implemented an amendment to the Education Act [12], inter alia, reduced fee for staying in the facility. At the moment when the child is in a public institution more than legally free 5 hours a day, a parent makes a maximum fee of PLN 1 per hour, before the decision belonged to the local authorities and the rates were varied and even several times higher than today. It should be emphasized that it is only free childcare, while for meals and extra activities in public institutions, parents pay the fee. It is also important to show that in the Czech Republic, Germany, Hungary, Romania and weekly number of hours that the child receives free child care is 40 hours.

With the introduction of "Kindergarten Act" assumes that until 2017 all children will be guaranteed a place in institutions. Today, however, are only guaranteed 5- and 6-year-olds, which necessarily fulfill the obligation to preschool preparation in "Class 0". Amend the law was necessary and useful, but in Poland there is still a big problem with pre-school education. The report of the European Commission shows that as many as 37% of Polish children before going to "Class 0" do not go to kindergarten.

This is the worst result in Europe, where in this group average in the house is only 11% of children. For comparison, in Bulgaria and Romania, the figure is approx. 26%, Slovakia and Hungary approx. 20%, 12% in the

Czech Republic and Germany, only 8%. The report indicates that in the school year 2012/2013 Poland was one of the few states where the law (except mandatory "Class 0") is not guaranteed to children in a kindergarten or nursery. For comparison – in Sweden, such a right already acquired year-old child, in most countries they are three year olds and the law applies to childcare.

In addition, worrying is also a reference the above statistics to costs incurred by Poland. It turns out that in Poland on childcare is spent 0.52% of GDP, which is exactly as much as the European average. For example, in the Czech Republic the figure is 0.49% of GDP, in Germany 0.46% of GDP, and 0.7% of GDP in Hungary. It is also worth noting that in Poland, 21% of expenditure on kindergarten comes from the parents, and the EU average is 14%. This percentage in Poland is closely connected with limited access to public institutions, which in turn forces the parents to use the services of private institutions [16].

4. Conclusions and recommendations

Family policy to bring results must be a long-term support system and not a mere collection of loose, incidental solutions. This is due to the fact that all the dysfunctions in this area involve long-term adverse socio-economic impacts on society as a whole.

Analysis of the solutions used in the context of family policy in Poland can make some conclusions. The proper functioning of the modern family threatens both the demographic, economic, and psychosocial factors. In the conditions of growing phenomenon of population aging is a key issue seems primarily targeted demographic policy, at least for simple reproduction of the population, or the replacement of the generations. So what should be done to persuade young Poles to raise families, which could meet the challenges of aging populations? Is Polish solutions are only fiction, or provide them with real support?

The answer to these questions is not clear and simple, and only introduces measures aimed at supporting families and children, and so it would not be sufficient. In order activities in the field of family policy to be effective, it is necessary first to address the issue of employment. In contemporary society the position of the individual in society to a large extent related to its labor market activity. High unemployment, especially among young people, as well as the lack of job security in the long term is not conducive to the establishment of the family. It would be worthwhile, therefore, to introduce programs to support both young workers and

employers that employ them. In this place should be proud of the efforts of governments to limit the so-called concluding contracts "junk". But it is not just about restrictions on contracts, which are not discharged social security contributions, and therefore does not collect employee capital needed to obtain a pension. It is also imperative reducing contracts of mandate (which are often the only source of income) in respect of which admittedly are paid social security contributions, but the nature and timeliness of such agreements among blocks the ability to obtain a mortgage, the interest rate should be reduced too.

Problems with obtaining a mortgage are very big, affecting not only the young people. Firstly, financial institutions require large "own contribution" and the interest rate discourages their borrowing. Therefore, should be assessed positively the changes that the authorities bring in the apartment for young (MdM), where it was decided to possibility to take the credit to a person who is not a member of the closest family. In practice, in addition to the young, to credit will join parents, grandparents, who will guarantee repayment. Despite the positive tone of these changes, it should be noted that such situations will result in a sense, dependence young families on borrowers and deprive the young families' independence and responsibility for their own lives.

Financial limits per square meter of real estate, which is the ability to buy an apartment in the MdM program, meant that the program applied only selected locations / estate. In order to meet the requirements for the purchase of forcing developers were cut costs, which often resulted in the acquisition of land for investment in not very attractive locations. The effect of this is that in the larger cities there were created "MdM enclaves" and some of the people who could benefit from the subsidy do not decide on the program, inter alia, by the unattractive locations or poor investment. The solution, which could affect the greater interest of the program there is the abolition the limit in the size of the property, while leaving the aid to a specific size of the property, as well as more expensive, increasing the amount to which the property can be purchased.

The issue of employment also appears in the case of solutions, which were introduced in Poland in the field of social security; particularly at longer receive benefits from childbirth. The introduction in 2013, the changes were expensive and clearly beneficial for young parents, and the ability to decide on the length of stay in the maternity allowance also deserves a positive assessment. The problem, however, lies in the fact that young parents need to ensure that after a year's break at work it will be welcomed back. On the one hand, the rules require the re-adoption – the

return to work of young parents after maternity leave, but on the other hand, the employer has the option to exempt them even a few days after returning. This situation, with relatively high unemployment in Poland, raises a number of legitimate concerns. It would be necessary to amend the rules that prevent employers' quick dismissals after parental leave.

Assessing direct, financial aid aimed at children, should be regarded as negligible. Benefits are paid only to the poorest, after fulfilling income criterion, which in principle is not practiced in Western Europe and Scandinavia, where child benefits are unconditional and are a real support for the family. Institutional childcare in Poland is also not the best, though, and so in recent years the number of places in institutions has increased. In this area, we should consider the actual and real support for employers who want to establish and run on their premises establishments providing care and educational services for children of employees.

In conclusion, the Polish authorities are trying to provide the best conditions for the development and functioning of young families. It should be emphasized that in the last decade, a number of solutions, which, however, only partially and selectively responding to contemporary problems, and Polish State aid aimed at young families in comparison to the authorities of other EU countries is at a relatively low level and through various activities should be increased and improve.

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ROMANIA'S PATH TO THE EURO AREA – THE IMPORTANCE OF REAL CONVERGENCE

Elena Raluca DUICAN (MOISESCU)*

Abstract. *The recent economic and financial crisis brought into discussion the importance of economic stability and the improvement of economic processes. In order to join the European Monetary Union, our country needs to accomplish the nominal convergence criteria that are stated in the Maastricht Treaty. In addition, even if they are not stipulated in the treaty, there are real convergence criteria to be fulfilled. This paper presents the concept of economic convergence, both real convergence and nominal convergence, in Romania, and it is showing their level of accomplishment in this moment.*

Keywords: *nominal convergence, real convergence, European Monetary Union.*

JEL Classification: E26, E42

1. Introduction

The recent financial and economic crisis has raised questions on the criteria for joining the Euro zone. It was raised the criteria reform for joining the euro area because of European Union (EU) enlargement from 15 to 27, then to 28, and because of breach criteria by Euro area Member States. The crisis has highlighted the asymmetry between euro area Member States and those outside the area. The criteria reform can be done on three levels: firstly, on inflation and interest rates, secondly on four criteria measuring a period exceeding one year and thirdly, a treaty change. [1]

In the context of the international crisis and non-congruence of the requirements between macroeconomic stability and economic growth, real convergence process seems to be a difficult one. From 2010, was adopted The European Semester, which includes procedures relating to the Stability and Growth Pact, the General Guidelines for the Economic Policies of the Member States and those on macroeconomic, fiscal and structural policies. This includes the structural reforms of intelligent, sustainable and socially inclusive growth Europe 2020 Strategy, it is introduced an objective for

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Member States to maintain a medium-term budgetary objective (MTO) related to the structural budget deficit and surveillance of macroeconomic imbalances. [2]

In 2009, almost all European Union member states had budgetary deficit, emphasizing the situation in some cases in 2010. Some countries have introduced fiscal measures (tax cuts or increased government spending) in response to the crisis.

This paper presents a brief history of Economic and Monetary Union (EMU) convergence criteria set by the Maastricht Treaty and their level of fulfillment in this moment in our country's accession to the Euro zone. It also stated that although there is no set of criteria, the real convergence has a great importance in joining the euro zone. The data used in the study are taken from the Eurostat database and covers the period between 2007 and 2015.

2. Theoretical aspects

Initial process of Economic and Monetary Union started a long time ago, even if officially Economic and Monetary Union began in 1999. In an effort to respect the properties of the theory of optimum currency areas, the European Union passed by the Single Market (where it had to fulfill features as: trade integration, mobility of capital and labor).

In 1957 the Treaty of Rome was signed, treaty which referred to the formation of the Common Market following several steps: forming a customs union and then an economic and monetary union.

In 1979, it was created in Paris the European Monetary System that targeted reducing inflation, stabilizing exchange rates and preparation of optimal monetary unification. Fluctuation band was set at ± 2.25% compared to the official parities. With the removal of capital controls, there is incompatibility between the fixed exchange rate, independent monetary policy and perfect mobility of capital.

Delors Report proposes the objective of creating EMU, going through three stages:

- The first phase (July 1 1990 – 1 January 1994) cover the full liberalization of capital movements, better coordination of economic policies.
- The second phase (January 1, 1994 January – 1 1999) provided: coordination of monetary policy, waiver of realignment parities, the creation of a central monetary institution.

– The third stage started from 1 January 1999. Delors Report provides orientation irrevocably fixed exchange rates and replacing with a single currency. The European Council in Madrid in 1995 decided to call the new currency euro. [3]

The theory of optimum currency area (OCA) has its origins in two articles written in the early ‘60s by Robert Mundell (1961 – considered “the father” of theory of optimum currency areas) and Robert McKinnon (1963). Those articles were debating contemporary issues on fixed exchange rates versus flexible exchange rates, the election being considered a more theoretical than a practical problem. The task of this theory was to make possible a monetary union. [4]

An economy with capital mobility and fixed exchange rate cannot have central bank independence. Incongruence between the three so-called “the impossible trinity” is analyzed by P. Kauffmann showing that monetary unification is the best solution for the European Union. It is based on the observation that, in 1991, the European Union has perfect mobility of capital. Mundell has identified the point where monetary independence is worthy, also the point where the factors ceases to be mobile.

Mundell's criteria were the subject of much discussion and controversy. It is therefore important to distinguish between labor and capital mobility criteria. Ingram (1959) argues that labor mobility is a crucial criterion for an optimum currency area. According to Corden (1972), mobility of labor is generally low.

The theory of optimum currency areas is studying the benefits and costs they incur when a country adopts the single currency. Benefits cover import of credibility of the central bank, while the costs refer to the effects of giving up monetary policy independence. It focuses mainly on cost minimization which depends on certain characteristics of the countries participating in the union.

Optimum currency area can be defined as a region where asymmetric shocks are absorbed without having to use the instrument of exchange rate and where waiving own monetary policy brings net benefits. [5]

F. Mongelli (2002) analyzes the OCA and establishes four phases: pioneering, in the early 1960s, reconciliation phase – the costs and benefits (‘70s), revaluation phase (‘80s-‘90s) and the empirical phase (covering the next 15-20 years). [6]

OCA properties are related to: mobility of production factors, flexibility of wages and prices, the degree of economic openness, diversification of production and consumption, the existence of similarities

inflation rate, fiscal integration, political integration and similarity of business cycles.

Some remarks on the first phase:

- Properties must be analyzed in detail, even though some are difficult to quantify.
- The criteria should be assigned and united under a large painting.
- A hierarchy of properties is not yet possible. However, price and wage flexibility and mobility are the most relevant factors.

If the factor mobility is high, then we can solve the problem of asymmetric shocks, capital mobility, labor are easing the adjustment process. Labor mobility reflects the fact that people move easily in response to economic incentives. In the context of price and wage flexibility, a shock will not generate persistent unemployment rate. These criteria formulated by R. Mundell is used when there is a shock on the demand side, the exchange rate is fixed, reducing real wages and labor migration can lead to balancing the economy.

In 1963, Robert McKinnon added another property, namely, the openness of the economy, which can be analyzed by the level of trade integration and country size.

About the second phase can say the following:

– It is trying to prioritize properties. Corden established in the top hierarchy the price and wage flexibility, and Ishiyama ranks first similarity in inflation rates.

– It adds the criterion of similarity of business cycles and shocks.

In 1969, Peter Kenen proposed as a criterion of OCA diversification of production and consumption. Monetary area Member States must be different and produce similar goods. The shock specific of a product has reduced consequences and affects similarly all Member States. The similarity of inflation rates (Fleming – 1971) provides stabilization of trade. Great differences in inflation rates are dangerous when are generated by the economy, by structural differences or different policies.

Fiscal integration is closely linked to political integration, and its first principal component is the Stability and Growth Pact (SGP). Regarding this criterion, Mongelli (2002) examines three versions of fiscal integration: fiscal convergence, fiscal stabilization and fiscal centralization. The criteria of the Maastricht Treaty and the Stability and Growth Pact direct fiscal convergence. Fiscal stabilization accounts for how the states meet the provisions of SGP. As governments have retained the authority to set spending and budget revenues cannot talk of fiscal centralization which involved the use of a supranational budget.

Political integration has several aspects: functional political integration (European Union member states already share a supranational framework consists of the European Parliament, European Commission, Council of the European Union Court of Justice of the European Union), the transfer of sovereignty on several elements of economic policy (centralization of monetary policy under the aegis of the European Central Bank) and the increasing need to coordinate policies.

Financial market integration leads to easier adoption of the single currency because if you remove restrictions on capital it reduces the differences between interest rates and no longer exist variations in the exchange rate.

The vital contribution of the '70s is introducing a new criterion, the similarity of business cycles. According to this property, the biggest threats of optimum currency area business cycles are asymmetric shocks.

Endogenous theory raises the issue of differences between countries and how these differences influence the formation of a monetary union. There are two scenarios: one optimistic that increased integration can lead to compatibility structures, and a pessimistic one, which does not preclude the occurrence of asymmetric shocks.

In 1996, Frankel and Rose argued endogenous character of properties OMA, under which a country could meet the criteria for joining a currency area ex post, not necessarily ex ante. A greater degree of openness of the economy will lead to a convergence of business cycles, which will provide favorable conditions for political integration and the creation of a monetary zone[1].

Another hypothesis based on the theory of trade and increasing scale economies is specialization theory. It is supported by Paul Krugman and tries to prove the contrary of endogenous theory, namely that trade integration can lead to specialization of each country in the production of those goods and services which have a comparative advantage and a low correlation to economic cycles.

3. Nominal convergence criteria

European integration implies more types of convergence: nominal, real and institutional. After joining the EU, a state must accede to Economic and Monetary Union as a result of the nominal convergence criteria established in the Maastricht Treaty.

[1] Socol, Aura-Gabriela, *European monetary integration, macroeconomics. The case of Romania,* Economic Publishing, Bucharest, p. 40.

Nominal convergence is a multilateral process, defined as the gradual approximation of national policy institutions and the Member States of the European Union, both in monetary and financial plan. [7]

After the 2014 deadline was missed, Romania aims to adopt the euro in 2019, which is supposed to enter the waiting area to adopt the euro, Exchange Rate Mechanism II (ERM II) in 2016; a favorable decision would come in 2019.

The Maastricht Treaty has provided for the imposing of restrictive conditions of member countries seeking entry into the euro area with a view to establishing a stable and sustainable monetary zone. The nominal convergence criteria are the following:

– the budget deficit not exceeding 3% of gross domestic product (GDP);

– public debt shall not exceed 60% of GDP;

– inflation rate over a period of one year before the euro zone access is at most 1.5 percentage points above the average of the first three member states with the lowest inflation;

– stable long-term interest rate (close to the level of the best countries in terms of price stability, that not exceed the maximum 2 percentage points the average interest rates of the three countries with best results of price stability);

– the exchange rate to be stable for at least two years, to respect the normal fluctuation bands of ± 15% provided for by the exchange rate mechanism before joining the State Economic and Monetary Union.

These criteria are based on economic motivation and monetary stability.

After admission to the European Union on 1 January 2007, the next step is the adoption of the single currency. For this our country must meet certain performance criteria.

For new members the transition to the euro, the EU Strategy consists of three stages. The first step is acceptance of the candidate countries in the European Union (free movement of capital).

Within the framework of the second stage it is required the implementation of programs and coordination of economic convergence with the other countries on the basis of indications from the Commission. Participation in the Exchange Rate Mechanism II involves binding the euro currency and maintains the exchange rate within a certain fluctuation band.

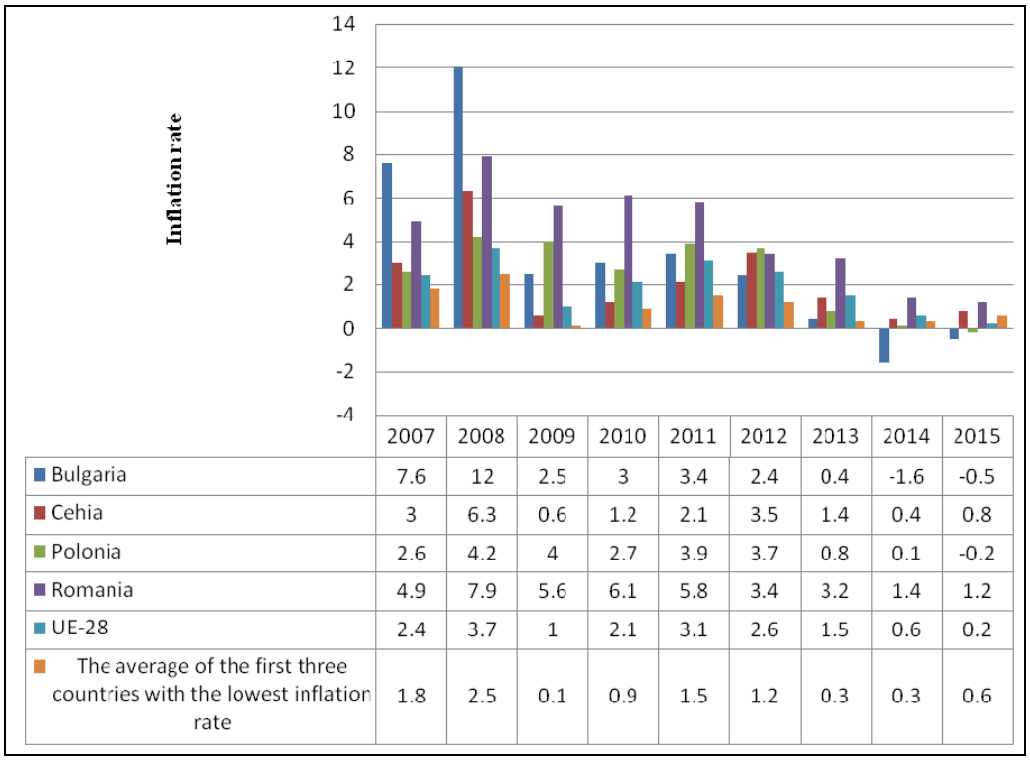
After nominal and real convergence criteria are met, Member States will participate in Economic and Monetary Union, introducing single currency euro. This last stage also implies giving up independence of

monetary policy and exchange-rate mechanism and compliance with the convergence criteria.

To see whether or not economies suffer major shocks resulting from the withdrawal mechanism of adjustment of monetary policy or exchange rate, we have observed two things: the level of compliance of properties optimum currency area and the convergence criteria.

Regarding the price stability criterion, it is reflected in the objective of the National Bank of Romania (BNR), according to its state. The strategy of inflation targeting was adopted in 2005 because monetary targeting was no longer an effective strategy.

It is observed (see Figure 1) that in the first years after joining the EU, Romania hasn't met the inflation criterion.



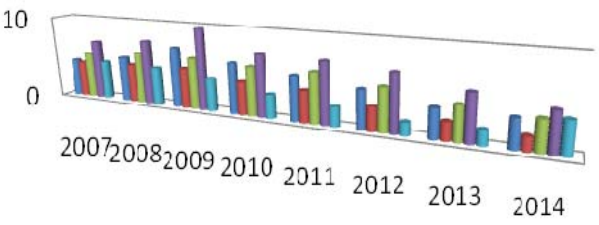
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bulgaria	7.6	12	2.5	3	3.4	2.4	0.4	-1.6	-0.5
Cehia	3	6.3	0.6	1.2	2.1	3.5	1.4	0.4	0.8
Polonia	2.6	4.2	4	2.7	3.9	3.7	0.8	0.1	-0.2
Romania	4.9	7.9	5.6	6.1	5.8	3.4	3.2	1.4	1.2
UE-28	2.4	3.7	1	2.1	3.1	2.6	1.5	0.6	0.2
The average of the first three countries with the lowest inflation rate	1.8	2.5	0.1	0.9	1.5	1.2	0.3	0.3	0.6

Figure 1. The average annual change in HIPC.

Source: Eurostat database, European Commission Forecast, 2015.

The criterion of long-term interest rate is linked to the inflation rate criterion. In 2005, our country issued government bonds with 7.49% interest rate, above the average rate. When the inflation rate reduces, it is easier for this criterion to be met, because the government bonds will be

issued at a lower interest rate. Regarding long-term interest rate criterion can be seen as follows (Figure 2), from 2014, Romania has met the criterion:



	2007	2008	2009	2010	2011	2012	2013	2014
Bulgaria	4.5	5.4	7.2	6	5.3	4.5	3.4	3.3
Cehia	4.3	4.6	4.8	3.9	3.7	2.8	2.1	1.6
Polonia	5.5	6.1	6.1	5.8	5.9	5	4	3.5
Romania	7.1	7.7	9.7	7.3	7.2	6.7	5.4	4.5
The average of the first three countries with the lowest inflation rate	4.6	4.5	3.9	2.8	2.3	1.5	1.7	3.7

Figure 2. Long-term interest rate.

Source: Eurostat database, European Commission Forecast, 2015.

In 2008, the first year after Romania joined the European Union, although the European Commission forecast was 3.2%, the consolidated budget deficit was 5.9% of GDP. Because this level was above the reference value of the Treaty of Maastricht, the European Commission recommended our country for measures to reduce this indicator. Certain elements favoring fiscal imbalances, such as an imprudent wage policy, the rapid growth of pensions and fiscal policy inconsistency can be removed from the Ministry of Finance by taking structural measures to strengthen the role of fiscal policy. This criterion has not been met either in 2009, when the financial and economic crisis occurs, the budget deficit reached –8.9% of GDP. They were taken austerity measures to reduce public spending, so in 2012 the deficit reached –2.9%, remaining below 3% by 2014. The impact of lower social security contributions by 5 percentage points was counterbalanced the increase in excise duties on fuel and the special tax on construction. For 2015, it forecasts a deficit of –1.5% of GDP (see Figure 3).

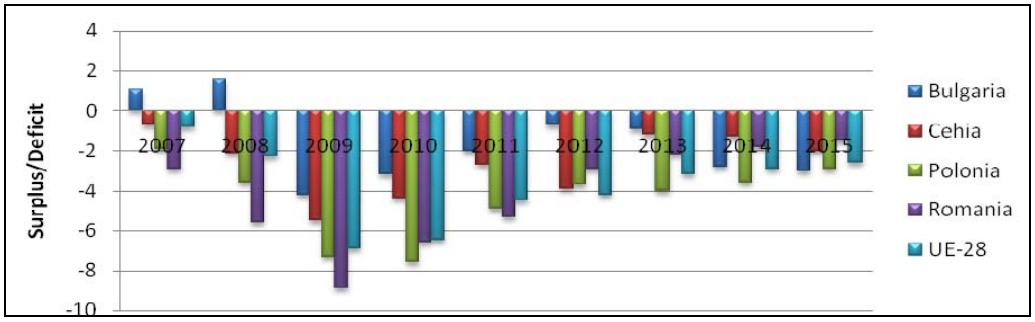


Figure 3. Budgetary balance.

Source: Eurostat database, European Commission Forecast, 2015

Government revenues have been decreasing due to the contraction of economic growth in 2009. Large budget deficits have led to a doubling of public debt from 13.2% of GDP in 2008 to 29.9% of GDP in 2010. The ratio of public debt to GDP reduced, below the EU average, gives a possibility to modernize the Romanian economy by contracting foreign loans.

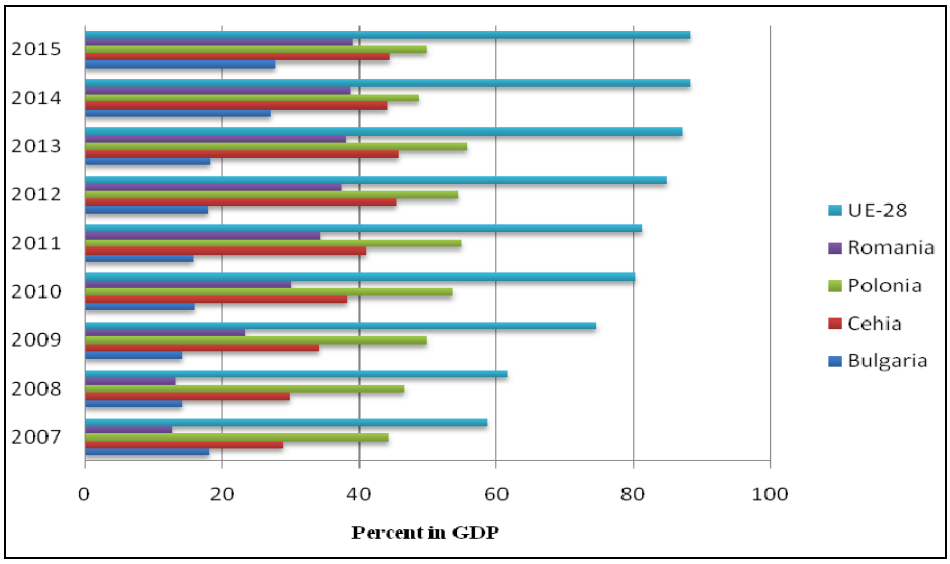


Figure 4. Public debt.

Source: Eurostat database, European Commission Forecast, 2015

Regarding the exchange rate criterion, the Member States may decide in the ERM II when the level of real and nominal convergence with countries belonging to Economic and Monetary Union is favorable to integration. Process flexibility of the exchange rate of the Leu started in 2004. Before entering ERM II, the currency must remain in a narrow fluctuation band of ± 2.25% and a broader band of ± 15% for two years.

Table 1.

The evolution of exchange rate compared to euro.

Country/ Years	2007	2008	2009	2010	2011	2012	2013	2014	2015
Romania	3,33	3,68	4,23	4,21	4,23	4,45	4,41	4,44	4,42

Source: Eurostat database

Among all the provisions of the European Semester, monitoring presents fiscal constraints on the process of real convergence. The structural deficit is defined as the budget deficit that exists where unemployment might find the natural rate of unemployment. Changes in the structural deficit are the effects of discretionary fiscal policy. Cyclical deficit is the difference between the current deficit and the structural deficit. When unemployment falls below the natural rate, the current deficit is lower than the structural deficit and has a negative value, and if the unemployment rate rises above the natural one, cyclical deficit is positive. Changes in deficit are caused by cyclic changes in the tax burden and government spending.

It is observed in Figure 5 that the structural budget deficit in Romania during the crisis deepened, reaching in 2009 to –9.7% of GDP. From 2011 the structural budget deficit slowed and amounted to –1.3% of GDP in 2014, approaching the level set by MTO, 1%.

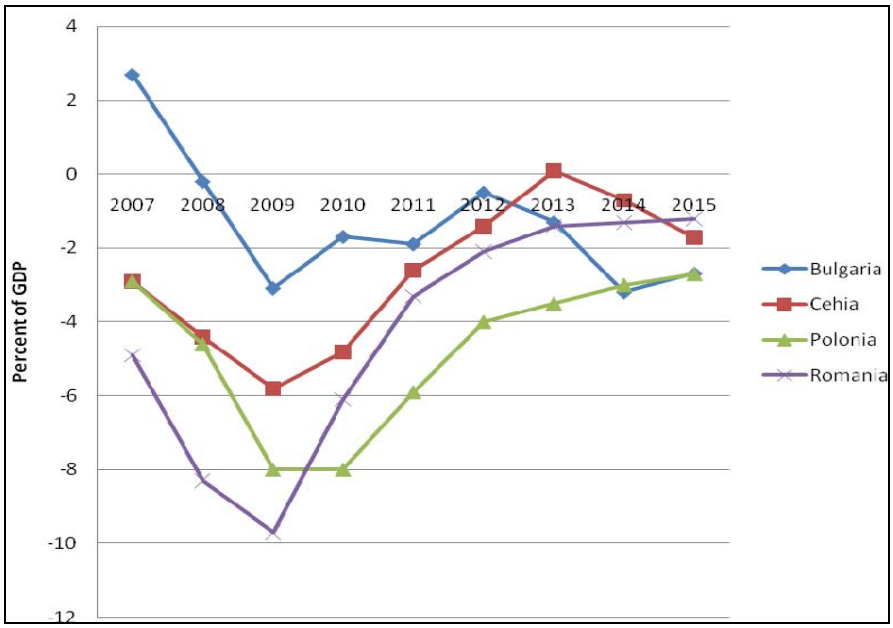


Figure 5. Structural budgetary balance.

Source: Eurostat database, European Commission Forecast, 2015.

4. Real convergence

Concerning real convergence to the EU average is spoken most often of GDP per capita at purchasing power parity standard. One can notice a decrease in real GDP per capita since 2009 and resuming the upward trend from 2011 to present.

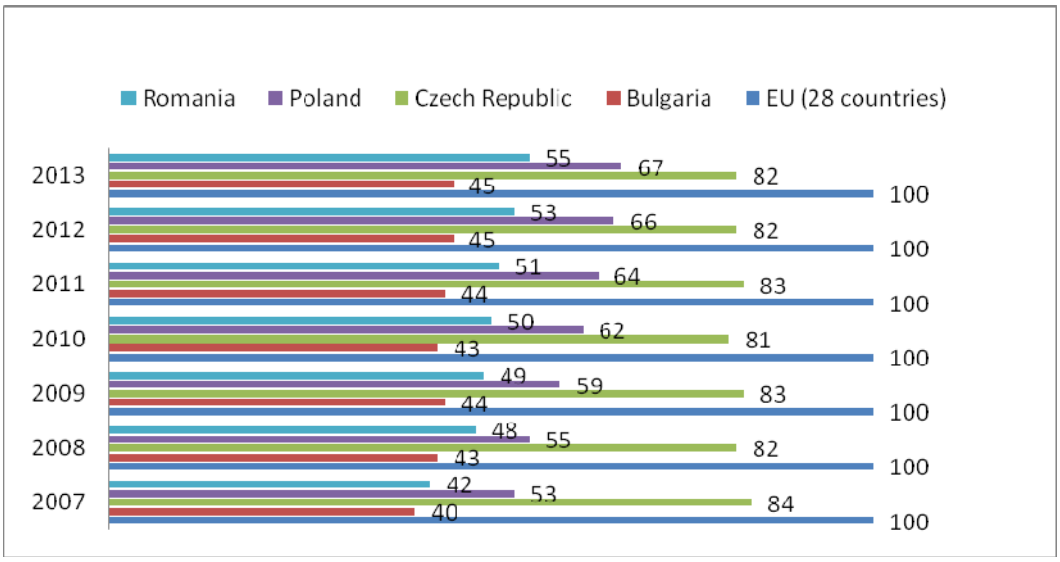


Figure 6. GDP per capita in PPS.

Source: Eurostat database.

It can be said that there was an improvement in living standards in the EU by 2009, when there is a decrease in the analyzed countries, except in Poland. Romania had a value of 55 percent of the european average, in 2013.

The convergence process experienced a period of stagnation once the crisis hit the economy in 2009.

Labor productivity is of particular importance in the process of real convergence. Also essential for participation in the single currency area are workforce flexibility (which depends on wage flexibility, labor mobility, functioning of labor market institutions, shock absorption) and flexibility of production factors. In Romania, labor market flexibility is very low, especially at regional level.

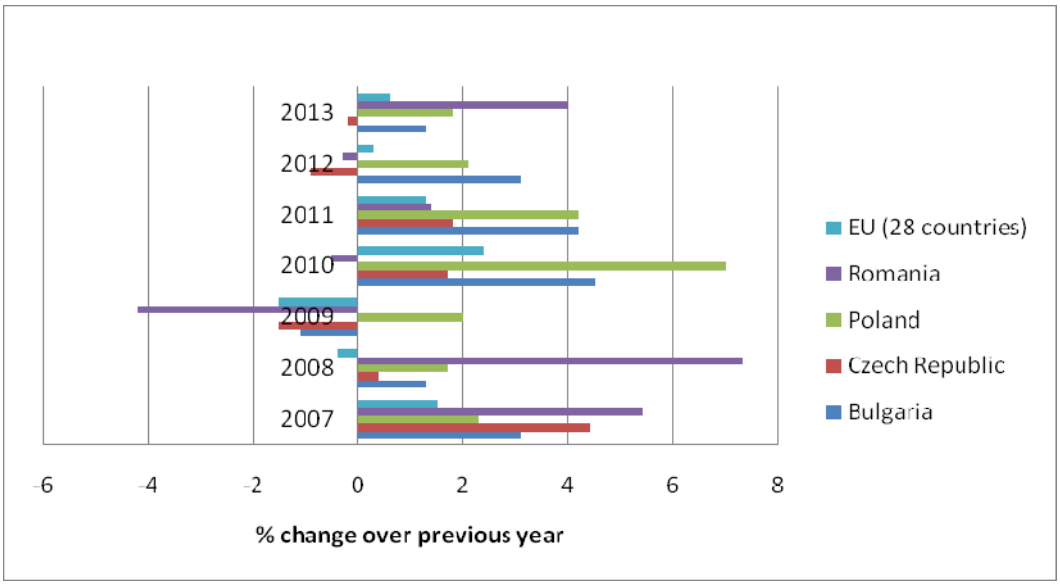


Figure 7. Labour productivity per hour workd.

Source: Eurostat database.

5. Conclusions

Achieving real and nominal convergence criteria is a test for Romanian economy. Although at the moment, Romania meets the criteria set by the Treaty of Maastrischt, our country must demonstrate that they are done in a sustainable way and can be maintained after euro area entry.

While before the crisis, it was prevailing the idea that there was sufficient nominal convergence criteria, the crisis has demonstrated the opposite, attention heading towards real convergence criteria.

The big challenge is to achieve real convergence but, due to differences between our country and the European Union. Current position established by the Convergence Programme, the year 2019, appears to be a good idea if it could contribute to more consistent macroeconomic policies and structural reforms on economic competitiveness in the euro area.

Acknoledgments

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RELATIONSHIP MANAGEMENT IN A PUBLIC-PRIVATE PARTNERSHIP

Zbysław DOBROWOLSKI[*], Wioletta WEREDA[**], Sylwia SACZYŃSKA-SOKÓŁ[***]

Abstract. *This paper is based on the author's own research and of other authors, and is an attempt to identify the conditions and the ability of public organizations for public-private cooperation, and suggests ways to improve such a partnership. The role of Intellectual Capital, as well as Relational Capital has been highlighted. For the realization and the co-financing of tasks by both public entities and private partners, an ignorance of concomitance principles constitutes a serious barrier to this public-private cooperation.*

Keywords: *public-private partnership, relational capital.*

1. Introduction

Public organizations functioning in today's turbulent environment are competing for resources. They can effectively pursue their goals, among others, through cooperation with other organizations. Public-private interaction (Public-Private Partnership – PPP) can be considered as an instrument of cooperation between organizations belonging to different sectors in the delivery of some tasks. Public organizations aim at implementing public interest. The organizations outside the public finance sector aim at obtaining a profit from their economic activities. However, public organizations as well as private organizations function in an economic environment and in the network of mutual dependence.

There are many research issues related to public-private interaction. For example, the impacts of PPP for economic development can be examined. Based on the analysis of research work of other authors, institutional and legal studies, documents published by different

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organizations, an attempt has been taken to analyze whether public organizations are prepared for PPP, taking into account their inter-relations in an economic network.

This article aims to establish the conditions and the ability of public bodies to public-private cooperation from the perspective of theory and practice of management science.

2. Public-Private Partnership and Intellectual Capital

In the available literature, a view is expressed, that the cause of the Inter-organizational cooperation has generated the need for achieving organizational goals in a turbulent environment. B. Gomes-Casseres, J. Child, D. Faulkner, B. Barringer, J. Harrison, JW Selsky, B. Parker note that organizations shall cooperate with each other due to a lack of specific resources [Selsky, Parker, 2005, pp. 851, 859]. J. Android, S. Waddock, JW Selsky, B. Parker note, that organizations cooperate in order to gain a competitive advantage. S. Linder sees public-private cooperation as an instrument of state policy, how to move the risk of public tasks in the conditions of an unbalanced budget on private organizations. Some of the researchers, like D. Osborne, T. Gaebler, note that the idea of Public-Private Partnership fits the concept of new public management [Selsky, Parker, 2005, pp. 851, 859]. Such comments have appeared that apart from outsourcing public tasks, public-private cooperation is a kind of privatization of the State's [Faranak, 2004, p. 89]. PPPs are typically medium to long term arrangements between the public and private sectors whereby some of the service obligations of the public sector are provided by the private sector, with a clear agreement on shared objectives for delivery of public infrastructure and/ or public services[1].

Taking into account a teleological approach, it is the relationship between organizations for the purpose of completing a project that will serve the public.Such cooperation should contribute to a better use of resources [European Commission Directorate General Regional Policy, 2003, pp. 4, 41]. Theparadigm for public-private cooperation assumes that the interactions between the actors of this interaction lead to a mutual benefit. Such an assumption seems too optimistic. Firstly, public-private

[1] http://ppp.worldbank.org/public-private-partnership/overview/what-are-public-private-partnerships [access: 16.05.2015].

cooperation can be an instrument used for the acquisition of public assets. Secondly, it can be used to build influence among decision makers, resulting in the violation of the rules of fair competition (private entity may deliberately incur some losses at the joint business in order to later win tenders due to "other treatment" by the decision maker).

Public-private interaction can catalyze organizational pathologies in the public sector, described by W. Kieżunas a relatively permanent disability of organizations, which causes a waste of resources beyond the limits of social tolerance [Ignatowski, Sułkowski, Dobrowolski, 2015, p. 58]. Narrowly, to the above definition, the generalization can be formulated, that the PPP pathology can malfunction in a recognized pattern, representing a brake on the development of competence. This is a situation where there is a disharmony between organizational, sociological, psychological elements. The pathology leads to destructive actions of both individuals and social groups.

The definition of public-private partnership in Polandis defined in Article 1 paragraph 2 of the Act of 19 December 2008 On Public-Private Partnership (Dz. U. of 2009. No. 19, pos. 100, as amended.), Hereinafter referred to in this article – law. The subject of public-private partnership for the joint implementation of the project based on the division of tasks and risks between the public entity and the private partner.

While the division of tasks is obvious, it requires a clarification of the concept of risk, furthermore the Act does not define this. Risk is defined, among others, as a situation in which the availability of various options and associated with each of these potential benefits and costs are only known to a certain estimated probability [Griffin, 2004, p. 285]. Risk is also defined by Z. Dobrowolski as the degree of probability as to how to define the objectives, their implementation and evaluation. Taking into account this definition, it is necessary to focus on this relationship.

The evaluation of the current state and prospects of financial commitment to public and private sector in the development of public-private co-operation in Poland has formed the subject of research conducted by the Foundation Institute for Public - Private Partnership and Business Advisory Law Firm Cieślak and Kordasiewicz. From the survey it shows that one of the main reasons for the low involvement of public organizations in public-private cooperation was a lack of financial resources. It was also pointed at the lack of preparation for such projects,

due to lack of qualifications of employees of public organizations [FIPPP, KDGCiK, 2013, p. 105]. 17% of all surveyed representatives of public organizations stated that they do not have any experience in the tasks in the framework of public-private cooperation (study included 470 subjects, including 320 who do not have any experience with the implementation of tasks in the framework of public-private cooperation) indicated a lack of credibility of private partners, and almost 15% of the absence of any knowledge of such cooperation. Over 25% of respondents feared that the cooperation with private partners in the framework of public-private cooperation will generate suspicions of corruption [FIPPP, KDGCiK, 2013, p. 107]. The research therefore shows that the level of confidence in the management of public organizations to the private organizations was low. The main conclusions that can be drawn from the above analysis is that it is necessary to continuously build the intellectual capital of PPP partners.

The relationship, as well as competencies and values are part of human capital. This human capital, which is directly related to the employees, managers, their skills, experiences, skills and education background is an element of intellectual capital. In addition this capital also includes also the structural capital and client capital, which can also be called the capital of stakeholders. The intellectual capital is the heterogeneous category, but important from the point of view of the organization [Edvinsson, Malone, 2001 Perechuda, Chomiak-Orsa, 2013, p. 306]. Intellectual capital is defined as: 1) the aggregate effect of education as well as experience gained, attitudes towards life, characterizing individual workers [Hudson, 1993, p. 16]; 2) the ability of the organization to adequate allocation of resources caused by the proper exchange of information [Petty, Gauthri, 2000, pp. 155-176, Rastogi, 2003, pp. 227-248].This capital is conducive to the success in achieving the goals of the organization, and if it is formed from the capital of PPP participants, can be considered as an important factor in the success of the implementation of joint tasks.

In light of the foregoing considerations, relationships are a key component of intellectual capital PPP participants. Relational Capital can be seen as an agglomerate of intellectual property organization, methods, techniques, procedures, data collection, used by organization or as a structure to maintain the interaction of an organization with its

environment [Perechuda, Chomiak-Orsa, 2013, p. 307]. The relational capital is conducive to internal organizational efficiency, but also represents value for its partners as it increases the inter-organizational efficiency. Trust plays an important role in the creation of this capital as it is also the result of such capital. Trust is defined, on the basis of management science, among others, as the ability of stakeholders to cooperate (Zbysław Dobrowolski), an element of social capital (Robert D. Putnam), a strategic resource of organizations (David J. Collis, Cynthia Montgomery). It reduces transaction costs, promotes effective cooperation between people, motivates decisions, promotes the exchange of information, encouraged to participate in transactions [Dobrowolski, 2014, p. 113, Grudzewski, Hejduk, Sankowska, Wańtuchowicz, 2007, p. 29, 31, McAllister 1995, Dasgupta 1998] will facilitate the coordination of organizations [McAllister, 1995, p. 55]. It is necessary to take into account that the PPP from the viewpoint of typology can be considered as the contract networks. Their feature is the spreading of risk and complementarity of professional competence [Boulanger, 1995].

It can therefore identify practical aspects concerning the relationship management within the PPP. Among the many partnership failures flexibility can be listed. The public organization acts in compliance with the Public finance Act as it requires detailed financial planning as well as compliance of other laws and regulations. Meanwhile, the private organizations have a more flexible budget and management through its objectives. Private organizations can plan the realization of a project in the long term. The planning in public organizations is influenced by the political situation. For example, the political composition of the municipal councils affects the decision-making of the executive authority of municipalities. Understanding the capabilities and limitations of PPP partners is crucial for the success of the implementation of joint tasks. A helpful tool in the understanding of these issues is a SWOT analysis, which should be carried out jointly for and by public and private organizations, assuming that they form one common entity – PPP organization. This analysis should also take into account the link of the two partners of the PPP with other entities, belonging to the network of relationships. Identify and analyze the influence of other actors on the course of the PPP is vital to the success of achieving the desired results. There is also no doubt that the joint identifying of opportunities, threats, strengths and weaknesses of

both organizations, as well as the common task – the PPP, promotes the creation of trust between partners as it helps in creating the relational capital.

Interaction between private and public organizations and their surroundings can be included in the model of the triangle interaction. This model indicates that the PPP and the actors of the PPP are influenced by the economic conditions, legal, technological, political and cultural. The effects of such interaction can be the same or different. Public and private organizations work with many stakeholders, customers, competitors, suppliers, and regulators. These entities affect PPP participants and the project itself. In turn, PPP has an effect on the environment.

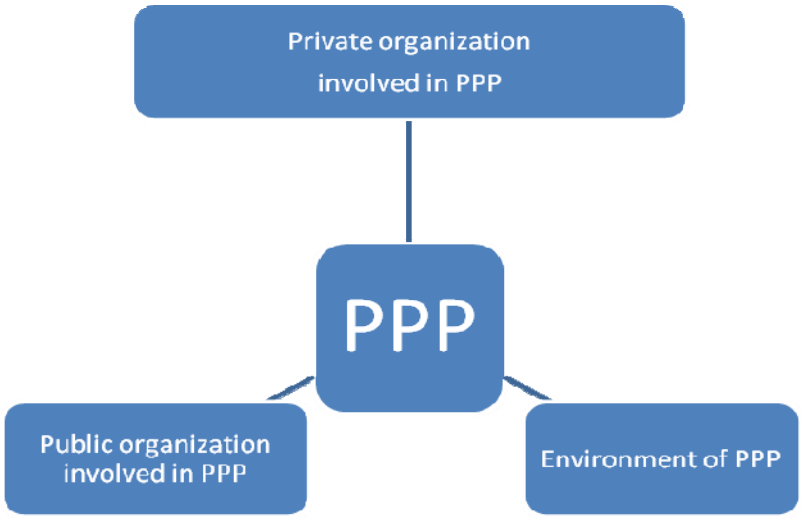


Figure 1. The Model of the PPP Triangle Interaction.

From the point of view of public organizations involved in PPP, the foresight method may be useful. Discussion about the future, in which various organizations participate, can decrease the risk of misunderstanding. The success of PPP depends on the mutual understanding of their respective interests by entities participating in the PPP. This should lead to an increased trust among partners, which is a unique asset, as well as being crucial for a sustainable competitive advantage. The common awareness of the necessity of continuous improvement of the measures undertaken should lead to improved results. PPP's Intellectual Capital model is shown below.

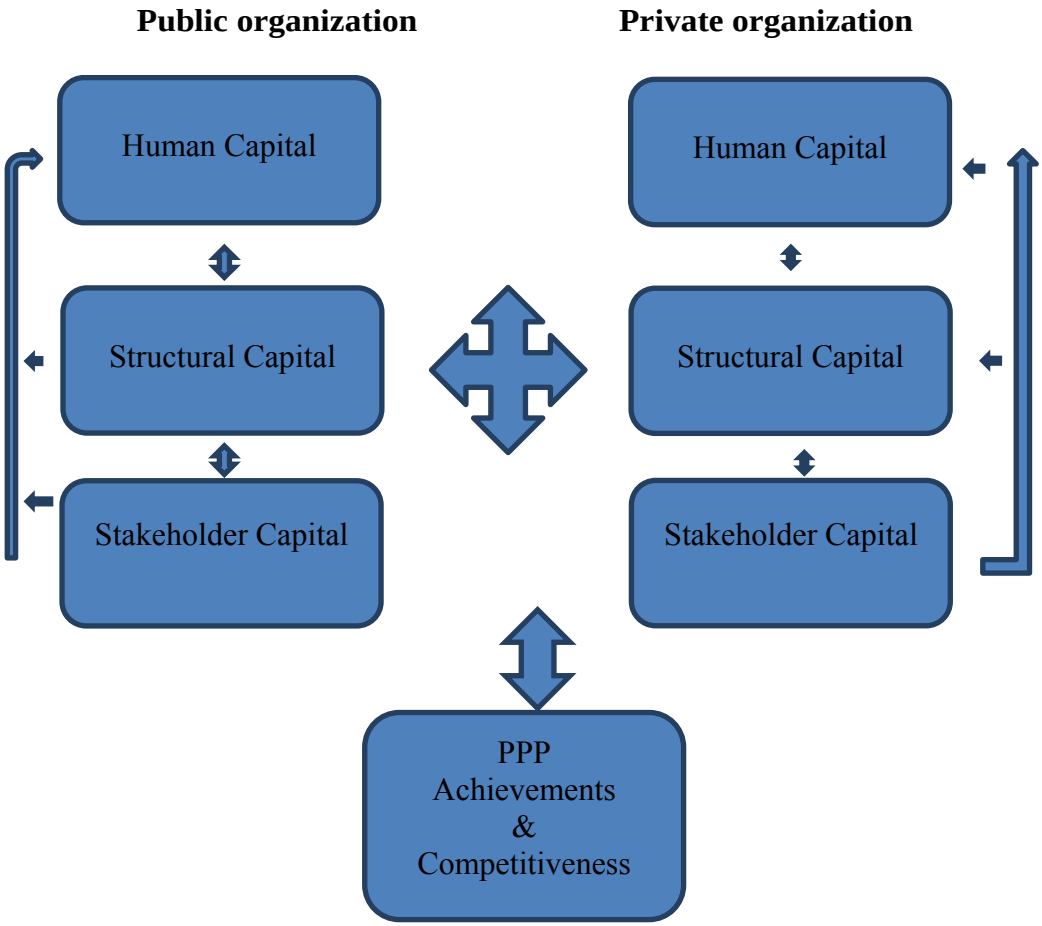


Figure 2. PPP's Shared Intellectual Capital Model.

3. Conclusions

Trust is a significant condition of public-private cooperation. This is facilitated by the negotiation of joint task, common SWOT analysis, which helps in risk sharing. The joint management of knowledge aims to build a shared intellectual capital as this capital helps in achieving competitiveness. Consequently the study of inter-organizational relationships is continually developing. Cognitive vulnerability concerns the role of inter-organizational relationships in PPPs, and relationship management within the PPP. The above considerations are not an attempt to formulate a new paradigm but rather an attempt by the authors to identify the desired direction of change in public-private cooperation.

There should be pointed out that there are also key drivers impeding and obstructing partnership cooperation as follows:

- lack of cooperation and lack of need for inter-sectoral cooperation;
- focus on performing present statutory activities;
- fragmentary actions taken;
- lack of sufficient technical and logistic background;
- lack of qualified personnel;
- relations "contractor – principal" instead of partnership relations;
- involvement in operations as a sub-contractor, not a partner;
- "bureaucratic" approach of public bodies;
- "demanding" attitude of social organizations [Wereda, 2012, pp. 118-119].

In conclusions, given the complex nature of the issue, establishing partnership implies embarking on initiatives intended to specify all activities to be taken in order to ensure a rewarding cooperation between partners. Beginning from the introductory negotiations through selection of partners, analysis of possibilities, identification of problems, exploring the potentials, allocation of assignments to oversight and accomplishment of tasks – to deliver objectives required which lead to social and economic growth of the local community. Pursuant to requirements for drawing up necessary documentation, the launch of the project in the form of PPP demands a relatively long preparatory period. This time should be devoted to intricate specification of details regarding cooperation as in each case of establishing a partnership; a guiding and essential objective is conducting operations for the benefit of local communities. It must be highlighted that PPP comprising a public entity and private partner is charged with securing the interest and promoting growth of the local community [Wereda, Dudzinska-Glaz, 2011, pp. 432-433].

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BUSINESS PROCESS MODELLING AS A TOOL TO IMPROVE PUBLIC SERVICES

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Abstract. *Public finance deficit makes it necessary to search for methods and tools to improve public services. Improving public services can be based on improving processes. Given the complexity and the number of processes in public institutions it becomes necessary to use computer tools of process management. The paper presents the possibility of using business process modeling tools to improve the processes of the public sector. The article uses the results of the research and development projects implemented in Polish public administration to illustrate the specificity of the public services. Based on the analysis of the possibility of the modeling tools used, the criteria of the efficiency of processes and multi-criteria analysis of customer's needs the principles of process modeling have been presented.*

Keywords: *BPM in Public Administration, Process Modeling.*

1. Introduction

Increased knowledge among citizens prompts today's administration to continually seek methods that enhance its performance. From among a great many concepts dedicated to improve administration likely to be applied, process management deserves special attention. Basically, the concept rests on the assumption that at the core of the improvement is optimization of processes rather than the optimization of function embraced in traditional concepts. Such an approach is consistent with the concept of the New Public Management, whereby measures proven in the business sphere are implemented in the public organizations. Putting the process management into place in public administration should, just like in the business sphere, trigger bolstered effectiveness and efficacy as well as improved quality of services provided [3]. Moreover, implementation of

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process management across public institutions is supported by the need to gain insight into the situation of citizens' needs, legal requirements and relevant alignment of the manner in which public services are delivered to them. With limited financial resources, any efforts seeking to boost effectiveness and quality of services allow for meeting needs among an increased number of citizens. C. Pollitt and G. Bouckaert propose that while assessing effectiveness of tools used in public management, it is necessary to take into consideration four levels of outcomes: operational, organizational processes, enhancing of positive system features and bringing public administration in line with the model of modern state [7]. Additionally, these levels may be employed for evaluating process management.

The focus on processes and common application of process management methods leaves organizations oriented on customer needs which are in line with one of the NPM models. The tools exploited in this model concentrate on citizens' expectations as to the quality of public services delivered. Modzelewski argues that flat organizational structures used for process management facilitate the quest for excellence and the assessment of operations through outcomes. Whereas A. J. Kożuch [4] proposed to base on the target costing combined with investigation of public services features significant from the recipients' viewpoint, while designing the reference process models. Overall, such an approach appears to be more comprehensive and to better incorporate citizens' needs.

When implementing process management into the public administration, it is typical to face resistance among employees. Essentially, this resistance largely results from the urgency for changes attributed to the fact that processes always tend to run across the organizational structure and they require delegation of powers by heads. On the whole, the method for assessing processes, put forward by A. J. Kożuch additionally involves citizens' participation. On the one hand, the participation exposes services' features being significant from the citizens' viewpoint, and on the other hand it reveals the financial ramifications for services delivery processes adjusted to these requirements. Thus, design of reference processes boils down to practical performance of services that are consistent with reference process models obtained in this way. This paper disputes the application of tools used for business process modeling while creating reference models for public service delivery processes.

2. Specifics underlying process management across public administration units

Due to feedback occurring in relationships with surrounding setting, public organizations should be classified as open systems with flexible boundaries constantly adjusting to these relationships [5]. Specific relationships of public organizations with the setting may be also observed while exchanging resources. Social participation in determining and shaping relationships with administration has a positive impact on efficiency of public services. Contribution to the decision-making process makes it possible to better customize operations to social expectations, thereby translating into a higher level of meeting the needs and increased citizens' satisfaction.

Polish public administration stands out for its high degree of formalization, rigid hierarchization and internal structure. These characteristics make it particularly hard to implement process management grounded on social participation. The research shows that the same processes executed across diverse public administration units are differently designed and conducted, and thus demonstrating the paucity of operational standardization, diverse levels of the quality, different costs across specific units [9].

The selection of the level at which public services are delivered seems key for the public sphere, because it drives tasks, duties and costs for running public administration. Execution of the increasingly growing public services basket requires crafting appropriate techniques and methods for operations, instruments adjustment and incorporation of numerous external factors. Frequently there is the need to find a middle ground, thereby opting for some operations to the detriment of others, or deferring decisions in time. Therefore, any improvement of administration's operations unleashes reserves, and thus allowing for delivery of public services to more persons in need.

The process approach regards the organization as a set of repetitive and clearly defined processes that mutually percolate. In business, such an approach aims at boosting competitiveness of organizations in a dynamically changing environment, whereas in the public sphere it allows for delivery of services with higher quality to a wider group of citizens. Principally, this is made possible thanks to decreased costs through clear designation of phases for process accomplishment, their monitoring and eliminating potential bottlenecks.

Initially, process management sought to optimize costs and production time. Such a perspective was adopted, for example, by Tylor. The development of management methods led to a new approach termed as Business Processing Re-engineering. The concept referred to radical overhaul of the organization structure and use of process management methods. Today, process management is associated with the concept of the Business Process Management and centered on effecting continual changes to organization functioning. At the heart of the approach is the overall view of the organization that enables the identification of all possible processes occurring within it. This concept presumes a broad support of business processes by IT tools in the form of software, reinforcing modeling of processes and stimulation of their accomplishment.

In general, process management has been put into operation across public institutions relatively recently, primarily in the context of implementation of quality management. This approach causes that the process is seen as a set of independent and mutually interacting operations that transform inputs into outputs. Put differently, the process approach tends to be constant and systematic recognition of processes within an organization, their management and continuous improvement.

From the business viewpoint the process is a set of interconnected, structuralized operations or activities which serve the specific purpose. Therefore, each business process is characterized by an explicitly formulated and measurable goal, identified input and output as well as repetitive and measured outcomes. The business process understood in this manner is typical to operations conducted by both business institutions as well as public sphere. Hence, it appears that tools utilized in the business sphere, following their simple adaptation, will be useful for modeling processes in the public sphere.

Given the specifics underlying operations that form processes, the following types of business processes are identified:

- managerial processes – supervising organization's operations, e.g. corporate governance, strategic planning;
- operational processes – conducting manufacturing or service operations, and participating in setting up a value chain, e.g. shopping, production, sales;
- auxiliary processes – supporting operational processes, e.g. accounting services, personnel services, technical maintenance.

The displayed classification of processes is consistent with the specifics inherent to public organizations. The distinctions between the business and public sphere do not originate from the manner in which

processes are run, but from the hierarchy of objectives significance, which has no impact on the specifics of processes. From the perspective of organization effectiveness it is important to define the process owner whose role is to supervise the progress and accomplishment of the process. Basically, such a person should understand the essence of the whole process as well as possess competences to pin down the tasks assigned to individuals and organizational units that execute the process. In the public sphere, due to the immensely formalized structure and prevailing culture of the role it is difficult, without organizational shifts, to indicate the owner of the process involving a few organizational units.

To gauge and enhance the processes it is essential to determine the measures likely to unequivocally evaluate their efficiency. In an effort to assess processes the following measures are typically used [1]:

- costs,
- quality,
- duration,
- flexibility,
- timeliness,
- relevance to an organization,
- relevance to a customer.

On the whole, costs, quality and duration time are regarded as principal measures. Thus, the gist of effective process management comes down to minimizing process costs, reducing duration time and enhancing quality. Improved quality and reduced duration time generally entails increased costs, and thus processes management is an ability to select such an alternative which delivers top quality product or service with the lowest possible costs within the time period acceptable to the recipient.

In the reference literature, the concept of efficiency is used for assessing the operations of the organization as well as its part. Specifically, the concept has a tremendously extensive and ambiguous scope. It is usually assumed that the efficiency is rated by the following measures:

- effectiveness,
- cost-effectiveness,
- beneficiality.

While assessing the level of objective accomplishment in terms of effectiveness, only anticipated outcomes of activities, without their costs, are taken into account. The degree of compliance between the effects of operations accomplishment with its assumptions is adopted as a measure of effective operations, whereas cost-effectiveness is a ratio between

outcomes of activities and their costs. The attention should be paid to the fact that while examining the costs of operations it is necessary to take into consideration their tangible as well as moral dimension. By linking cost-effectiveness with effectiveness it should claimed that those who approach (??move) closest towards the objective projected and at the same time making lowest investments, function more efficiently, in other words this is a specific trade-off between needs and possibilities.

Beneficiality is mostly understood as a difference between the value of activities and their costs. Therefore, we deal with beneficiality of activities when the outcome of activities is higher that costs incurred. Otherwise, we talk about the adverse impact. Władyka M. argues that in the case of activities with the same cost-effectiveness and degree by which they approach the objective set, those distinguished by higher beneficiality tend to be more efficient.

Meanwhile, assets complimentary to efficiency are precision, simplicity, rationality and reliance. The significance of extra assets for gauging efficiency is rather marginal in its character and it is frequently ignored while assessing the efficiency of activities.

Dimensions of efficient activities are applicable as a criterion for evaluating the organization of all sectors. However, it should be kept in mind that while assessing the organization across business sector, the efficiency assessment is greatly facilitated, because operating profit is a primary and easily measured assessment criterion, though its application as a efficiency measure carries some shortcomings which are addressed in detail by Domańska-Szaruga [1]. Regarding operations conducted by public organizations, measurement of efficiency presents some problems, as the effect of organizational activities does not help to attain benefits by it, but seeks to satisfy social needs. The level of this satisfaction is hard to be gauged, and thus the efficiency assessment itself may have some errors.

Recently it may be noticed that measures used in the private sector are commonly adapted to the public sphere. Principally, this is driven by limited revenues and related necessity of enhancing activities efficiency. Yet, while implementing methods and techniques proven in the business sector into the public sector, it is crucial to do so with particular caution. Differences in the specifics underpinning the operations conducted by business and public organizations may lead to the solutions efficiently functioning while not producing the benefits anticipated but actually causing losses. Therefore, it appears expedient to design the patterns for

activities conducted by public managers and rested on process management while assuming that the assessment of processes will incorporate the specifics of the public sphere, based on the measures proven in the public sphere.

3. Electronic tools used for modeling business process

In the context of process management, process modeling should be viewed as a set of activities performed by process analytics within an organization. Hence, process modeling aims at mapping out the manner in which an organization operates and designing improvement methods. The modeling effect is the presentation of the process model perceived as a structured, mostly graphic representation of the process. The representation depicts the progress and sequence of specific process steps.

In process management practice, modeling is frequently associated with mapping of processes. However, these concepts are not synonymous. Broadly speaking, a map merely shows relationships between processes and objects in the process, whereas a model demonstrates the progress together with all characteristic performance parameters and indicators. Having analyzed the model, the conclusions may be drawn as to the impact of potential disruptions on the process, and diverse decision-making variants may be theoretically verified without any actual activities and incurring related costs.

Business process modeling is related to the need for graphical representation of business processes designed for their optimization and documenting. Appropriate creation of the process model requires familiarity with the whole organization's structure, the process objective and resources involved. An important aspect for modeling is the choice of certain notation, used for modeling the specific business. Currently, the notation that received the largest popularity is ***B**usiness **P**rocess **M**odeling **N**otation* (BPMN) designed to modeling processes.

As revealed by Bitkowska, tools that shore up business process modeling may be classified as follows: [1]:

- tools designed for building diagrams – principally used for visualizing and mapping processes (Microsoft Visio, Flowchart (Micrografix),
- CASE tools – used for modeling processes that are integrated with IT solutions (Designer 2000, Oracle, Select Enterprise),

- tools for designing and improving processes – they allow for advanced analyses and simulation (ARIS Toolset, Igrafix, Adonis),
- tools for modeling processes within the system ERP.

The selection of the tool and notation plays a tremendously vital role at further work phases. IT developed a specialist language applied for object modeling – Unified Modeling Language UML. The application of this language seems to be the best solution for IT-aided business process modeling. Though, from the perspective of the business user, the solution poses challenges because it requires IT knowledge concerned with object perception of the reality. This knowledge area is particularly hard to be transferred to persons without any IT education and background. In an effort to facilitate processes mapping, the standardization primarily based on **B**usiness **P**rocess **E**xecution **L**anguage (BPEL) and BPMN was put into place, thereby combining advantages brought by object approach and standards for business process modeling.

Overall, IT tools designed for modeling processes respond to the need of graphical illustration of the events sequence. Specifically, these tools are exploited for optimizing and monitoring of process effectiveness, planning of organizational structures, generating descriptions of job positions, keeping accounting of process cost, and implementing quality standards [6]. Broadly these tools make it possible to visualize processes as well as model, coupled with the opportunity of effectiveness simulating and its assessment. The instance of the tool used for modeling processes as well as comprehensive managing them is a product offered by the company BOC – Adonis. The concept of the software originated at the University of Vienna. Today the application enables mapping processes, analysis and simulation of tracks, analysis of costs carriers, automatic generation of documentation and so forth [8].

Simplicity and low number of symbols used for depicting processes makes the schemes, devised by their means, are characterized by their immense clarity and ease in interpretation. Furthermore, the universality of the notation provides the possibilities of transferring models across various applications.

The primary objective of process modeling is:

- to understand the manner in which an organization operates,
- to depict processes accomplished,
- to assess effectiveness and performance of processes,

- to map out possible improvements,
- to evaluate the compatibility of processes with the strategy,
- to programme changes and new solutions.

The IT solution proposed allows for bringing together processes mapped with the organization's resources and current organizational structure. Due to the solution it is likely not only to optimize processes but also to define the extent to which resources were harnessed and outline encumbrances of individual organizational units.

Adonis as a system supporting the process management may operate in the following modes:

- modeling,
- analysis,
- simulation,
- evaluation.

In the modeling mode, data illustrating an organizational structure, resources available, documents used, schemes for process sequence and parameters revealing resources involved are entered into databases of applications. On the whole, data entered into the system include, among others, costs of specific activities, their duration time and quality parameters. Thus, this helps to, among others, automatically generate summaries disclosing reserves and bottlenecks while tapping into resources. Moreover, having mapped processes it is possible to automatically generate documentation for processes, alongside documents critical for their execution. Meanwhile, the modeling process itself is carried out with the use of fairly intuitive graphical interface that is largely intended for creating a process map. Parameters illustrating the process (duration time, costs, etc.) may be entered in the graphical mode during process modeling as well as in tabular mode after modeling is completed.

The analysis mode seeks to prepare a statistical analysis of processes. The application makes available a wide variety of pre-defined reports and tools that enable generating reports according to individual criteria. Then, reports compiled by applications allow analytics to produce analyses and conclusions for improvement.

From the perspective of process improvement, the core functionality of the system is the possibility of generating simulations illustrating the course of the process with parameters entered. Accordingly, it is possible to judge the consequences of changes projected, determine the need for personnel, identify bottlenecks, pinpoint work burdens and specify the duration time for both the whole process as well as for individual operations.

The ongoing process management is buoyed up by the evaluation function. In effect, introduction of actual data into databases gives an opportunity to compare the manner in which process is executed with model assumptions. Based on that, non-conformance reports are prepared, thereby exposing problematic activities and critical resources. Due to these analyses, it is possible to swiftly correct activities and minimize adverse effects sparked by non-compliance between actual course of process and projected course.

The exploitation of electronic tools intended for process modeling across public organizations facilitates update for course of process, triggers swift implementation of changes and standardization of operations performed by administration. Adequate process modeling minimizes the number of bottlenecks, reduces the completion time and helps to assess the use of resources.

5. Business Process Modeling on the example of the intelligent municipality

In response to the intensification of global competition, many organizations throughout the world have developed international operation strategies to establish a worldwide production, distribution and marketing network. In the era of knowledge economy, companies are facing dynamic competitive and rapid changes in global marketplaces. They have to emphasize the creation, accumulation, diffusion, transferring and application of knowledge to accelerate product, service and process innovation and value creation to meeting the needs of customers. There is an increasing importance of innovation in which knowledge turns into the main source of competitive advantage. Innovation in private and public sector is one of continuous interactive learning that occurs in the context of formal and informal relationships between organizations. Innovation can assume many forms, including incremental improvements to existing products, applications of technology to new markets, and uses of new technology to serve an existing market. This process is not completely linear. Innovation requires considerable communication among firms, laboratories, academic institutions, and consumers – as well as feedback between science, engineering, product development, manufacturing and marketing [12].

According to W. Wereda the model of transformation of the traditional municipality into intelligent one should be supported by different tools of Business Process Modeling. The factors determining an

advantage enjoyed by the intelligent municipality in the region, alongside effective management of finances (capital resources) principally include:

- Exchangeable relations and value transfers for partners;
- Efficient exploitation of the territory of the municipality (land resource) and its workforce (labor resource);
- Creation of marketing image of the municipality (also through good brand and image);
- Promotion of the municipality;
- Use of state-of-the-art techniques and IT technologies in establishing and maintaining relationships with partners and interest groups [10];
- Effective governing by individuals adequately selected and professionally groomed and educated in the field of public management;
- Treatment customers as partners of the municipality, not applicants (enhancing the quality of handling customers from each interest group, partners/stakeholders).

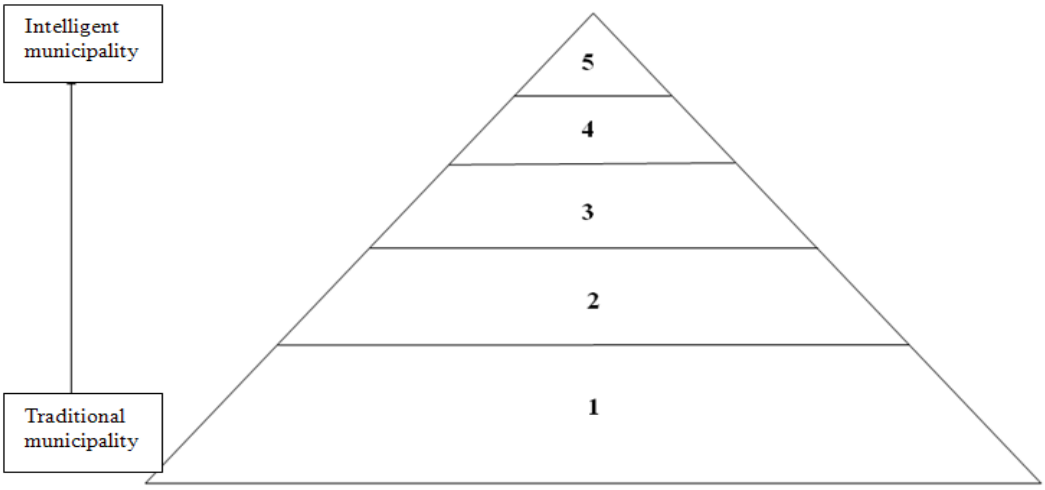


Figure 1. Transformation from traditional municipality into intelligent one.

Source: author`s own elaboration.

Explanation:

1 – meeting the needs of the local community at the primary level and executing tasks specified by the law;

2 – developing of the growth strategy and the creation of the municipality management programs in times of crisis, as well as seeking sophisticated sources of financing;

3 – building a good image of the municipality and promotion of the unit (using the latest techniques and information technologies) to establish and maintain relationships with partners and stakeholders;
4 – belonging to different organizations and participation in the rankings of local, regional, national and international fairs, exhibitions and other events within a range of at least regional level;
5 – creation of own "intelligent" image of the municipality in the region, as well as the use of knowledge and value innovation in the municipality of relying primarily on inter-organizational relations, stakeholder relationship management and other aspects of business process modeling.

When creating an intelligent municipality, local authorities should harness in its functioning seven core "habits" which distinguish it from traditional municipalities. These cores should mainly be supported by different aspects of business process modeling:

1. An intelligent municipality has leaders (front men) who persuade a local community that more is to won than lost by "hooking up" to a so-called local broadband economy[1];
2. Intelligent municipality is open to shifts;
3. An intelligent municipality fosters visions inspiring to activities and sets ambitious viable objectives;
4. Intelligent municipalities create "heroes"- leaders;
5. Intelligent municipalities "do not rave" about technology, but as far as reasonably possible put in place technological solutions (Bell, Jung, Zacharilla, pp. 22-32);
6. An intelligent municipality creates its image in the region and across the country;
7. An intelligent municipality nurtures relationships with its partners and interest groups through improving customer service;
8. An intelligent municipality develops e-administration and continuously improves the functioning of the Office in the direction of pro-client orientation [11].

[1] Local broadband economy characterizes by establishment of new companies and industries on the local area; boosting local firms to convert them into global exporters; enabling export and import of knowledge and skills; giving local school access to latest information; combining local health centres with leading medical centres to exchange experiences; combining enforcement of local law with national data templates; allowing local business and units to seek out global trade partners offering products with low costs and high quality; augmenting involvement among local community in the use of internet tools and new technologies; implementing service and product innovations on the local market.

6. Conclusions

The specifics behind Polish administration cause that, even though operations carried out by public administration units rely on the same laws, each administrative body executes the public services delivery process in a different way. In essence, the differences between processes not only lie in duration time, but also in their quality. In many cases, services offered to citizens prove to be overly costly; their execution takes too much time, thus revealing a waste of public resources.

Extensive implementation of methods and tools reinforcing the process management in public administration should prompt elimination of errors in service delivery processes at the first phase across administration bodies. Process modeling and their connection with documents and legislative acts allows for conducting a review of legislative acts and procedures applied in administration bodies. Subsequently, processes modeled will be subject to analysis and improvement. The improvement should be accompanied by examinations of inhabitants' needs showing significant features of services provided. So, the services defined in this way will better meet citizens' needs.

Taken together, a combination of model bases from various administration bodies helps to establish benchmarking and indicate reference course of processes. Reference processes should be marked by the lowest cost, shortest time and quality expected by recipient. The modeling process appropriately executed should also place an emphasis on handling exception and non-standard situations.

To recap, a reference model base, developed and continually upgraded, may also be a valuable tool for testing any types of changes ahead of their implementation. When it comes to the public administration, a reference model base may be used for initially assessing costs incurred by implementation of alterations to legislation as well as public services delivered.

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NEW INFORMATICS CHALLENGE FOR IMPROVING DECISION LABORATORY (D-LAB) ACTIVITY

Oana Andreea CĂLIN[*], Raul ŞERBAN[**]

Abstract. *The paper will present the challenge of developing an informatics solution for decision laboratory (D-lab) activity. The main objective of this paper is to integrate the theoretical decision concepts in an informatics solution to improve the laboratory activities. The integration of informatics activities is an important education process element in order to achieve high and performing results. The proposed solution will help the students to better understand the theoretical decision concepts and to optimize the performance of existing decision laboratory activities.*

Keywords*: decision, D-lab, informatics solution.*

1. Introduction

The decision process design represents one of the main problems in the development of safe industrial systems. The aim of the paper is to find solutions for improving the learning process in decision and diagnosis field. In engineering universities the students must be able not only to extract the skills acquired in classes or laboratory activities but also to connect the theoretical information to the real world (Mohora et al, 2009). An efficient teaching process is based on understanding theoretical concepts and solving practical problems.

This article will present an idea for improving teaching process decision laboratory activities using an integrated informatics solution. The challenge of this article is to present an informatics solution used for the teaching process and laboratory activities in diagnosis and decision field. The proposed informatics solution will be centered on students and their capacity to choose the right technical decision using theoretical skills and knowledge. The proposed informatics solution will follow a specific methodology. The figure 1 illustrates the steps of this methodology proposed for D-lab activity.

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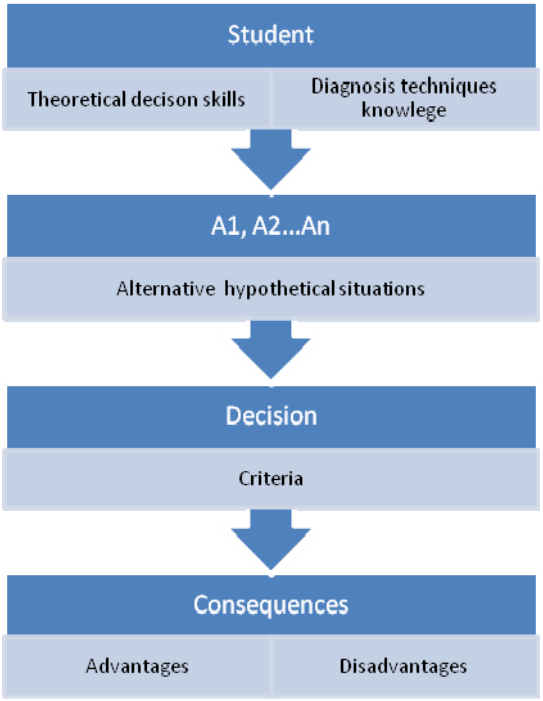


Figure 1. Methodology steps.

The proposed methodology will also try to identify how many students are working better and understand more about decision theory when they are using the informatics solution for solving decision problems. The proposed informatics solution will be designed at the beginning only for improving learning activity in decision laboratory (D-lab).

Using this practical method the students could analyze the consequences of their decision for a virtual industrial situation. In each case the students must learn that every decision has its own advantages and disadvantages.

2. The informatics solution development

The education aim is to improve the university activity and to add value to the learning process (Mohora et al, 2009). The aim of the paper is to find new methods for improving the high education process using a new informatics solution for D-lab activities. This informatics solution will contain theoretical principles about orientated graphs and decision tree and also an application module. The application module will help the students to build the decision trees and to compare and analyze different solutions. The specific software could be also an open source decision program. The

application module will contain web technologies such as HTML, PHP or MySQL. Figure 2 will present the connection between main elements of this integrated informatics structure.

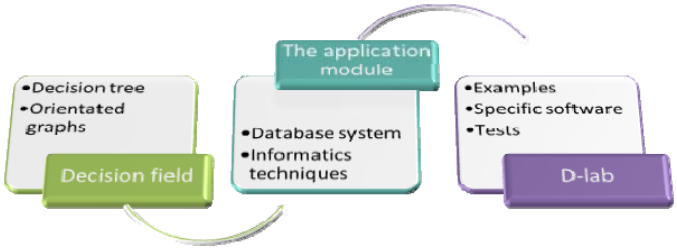


Figure 2. Informatics structure elements.

The main objects of using this integrated informatics structure are: the optimization performance of existing D-lab activities by using new learning methods and also improving the quality and the attractiveness of laboratory classes. Also a continuous communication between the student and professors must exist during the whole learning process. The proposed solution will better help the students to understand the real applicability of decision theoretical principles and be able to propose and develop their own solutions. That is why the proposed informatics solution tries to develop a flexible way to think and the students must be able to connect the technical information to a practical situation (Serban and Calin, 2014). A good and efficient D-lab activity is a lesson that could be understood by each student.

3. Application fields

The proposed informatics solution is a pilot project but it could be identified another possible areas of application. Two important benefits of this proposed informatics structure is:

– the solution is not limited just to decision an diagnosis field;

– the solution could be integrated to other teaching fields.

The proposed solution could be also used to study decision problem for other engineering laboratories. One of these is the laboratory activity for computer aided production field. An example is the decision to optimize the production in a flexible manufacturing system. Using specific software a student could analyze the simulation results and take a decision to optimize the production system. For example in a production

hypothetical production situation the student must decide between three possibilities:

– to reduce the arrival parts time;

– to modify manufacturing system cycle time;

– to change the machines programs.

The proposed solution could be also used to study decision problem in other scientific fields such is economy. The economy represents a complex system and the economic decision could have a great deal of subjectivity (Spanulescu and Gheorghiu, 2013). Using this proposed solution the students could investigate and understand the economic phenomena and processes, some methods, theories or models particularly from the exact sciences.

The decision analyses and the proposed informatics solution could help the student to identify an optimization strategy for every resource or for whole manufacturing system. Connecting the new informatics technology with theoretical concepts of decision and diagnosis for industrial field the paper proposes a solution for practical labs activities. The solution could better help the students to understand theoretical principles and to solve practical decision problems in technical field.

Using the theoretical decision concepts and the informatics solution a student could achieve an optimization strategy for the whole manufacturing system, based on simulation and experimental dates.

4. Conclusion

The main objective of this paper was to present o solution for improving the decision lab activities. At this moment the proposed informatics solution is at the beginning but after the implementation could become a successful story. The paper presented the main idea and the steps for developing the proposed informatics solution.

Two important advantages of integrating of the proposed solution in D-lab activities are:

- The optimization of the existing D-lab activities by using new learning methods.
- The improvement of the quality and the performance in teaching process for decision classes.

The paper described the development principles of an informatics solution used especially for decision laboratory (D-lab) activities. The aim of the paper was to present the connection between an informatics solution and a learning methodology for decision laboratory.

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THE RELEVANCE OF CBA IN ASSISTING THE ALLOCATION OF EU FOUNDS ACROSS PROJECTS

Anca CRISTEA[*], Mădălina Cristina TOCAN[**]

Abstract. *In an economic context characterized by the balance of 2007-2013 SCF exercise revealed an absorption rate of 54,82 % in the case of Romania, cost-benefit analysis (CBA) plays a decisive role in informing public investment decisions. Beginning with the CBA experience under the Structural and Cohesion Funds of the other important European states, the paper analyze the main developments over the last decade. It presents the relevance of CBA in assisting the allocation of EU funds across projects. In a particular way, it shows how the 'funding gap' method used to determine the level of Community assistance and prevent the crowding out of other sources of finance by increasing the leverage effect and creating incentives for attracting private capital. Analyzing the Romanian situation, the paper presents the most important policy implications in terms of trade-offs and incentives.*

Keywords: *cost-benefit analysis, structural funds, EU Cohesion policy, absorption rate.*

JEL Classification: *D61, E22, F15, H43.*

1. Introduction

To provide a judgment about the *values* like projects, policies, programmes represents an evaluation in this direction. As a discipline, it is driven by three interacting factors – theory, practice and learning[1]. In an ideal aim, it should build on the most advanced theoretical developments; the analysis should be developed from a perspective that is informed by practice; in other case it should promote learning from evidence gained.

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The increasing awareness of and need for economic evaluations is now well recognized by researchers and practitioners undertaking them. It is well known that the quality of economic evaluations is a mix, and therefore the value of this kind of studies is a decision of the makers and it is often questioned. Governments have limited resources to spend on public investment projects. So they need to conduct economic evaluations to chosen a limited set of projects in order to ensure that welfare pluses are maximized. The methods adopted for conducting economic evaluations are many represent the particular question or hypothesis being examined. An ideal economic evaluation would be based on high-quality data be internally valid or for externally valid, being capable of generalization to other settings or countries.

One of the main objectives of EU Cohesion Policy promote by Romania is the economic and social one in order to achieve the member States convergence. The EU Cohesion Policy for the period 2007-2013 was supported by a budget of 347 billion EUR. As it is presented in table no. 1, the Structural and Cohesion Funds allocated for Romania are 19.2 billion EUR.

Table 1.

The absorption rate of SCF per financing programmes in Romania, cumulative in the years 2007-2013.

Operational Program	EU Allocations (billion EUR)	RU Reimbursements (EUR)	Absorption rate (%)
Regional	3,966	2,498	62.99
Environmental	4,413	2,061	46.41
Transports	4,288	2,521	58.79
Increase in Economic Competitiveness	2,537	1,475	58.16
Human Resources Development	3,476	1,616	46.53
Administrative Capacity Development	208	169	81.20
Technical Assistance	170	106	62.24
TOTAL	**19,058**	**10,447**	**54.82**

Source: The status on 30 June 2015 of submission and approval of projects contracts signed and of payments to beneficiaries, The Ministry of European Founds, Romanian Government, October, 2015.

This situation proves that Romania has big problems in preparing, contracting and implementing projects. It also points out the relevance of CBA in assisting the allocation of EU funds across projects.

The paper is organized as follows: the EU cohesion Policy and cost-benefits analysis, the responsibility of applying of CBA and the future of this kind of economic evaluation.

2. The EU cohesion policy and cost-benefit analysis

Public sector intervention, as a point of view of EU cohesion policy, represents the form of a public investment project, with public-private investors (PPP). The Community assistance is in general given in the form of non-repayable grants, although there is an increasing trend to shift towards repayable grants, especially for SME support.

We consider that interventions under EU cohesion policy mainly perform an *allocative* function, in aim to look at efficiency targets such as increase in productivity and output growth. However, in many expenditure programmes, trade-offs exist between the objectives of efficiency and equity, and the EU regional policy is mainly the rule.

Therefore, the objectives of the EU cohesion policy are pursued in a complex multi-level government setting[2]. At the start of a programming period, each country's financial allocation is decided on the basis of relative socio-economic conditions such as regional and national prosperity, unemployment rate and population (Figure 1). In these conditions, we can decide that during the programming period, every region must establish the following objectives:

a) The absorption of the allocated Funds will be maximum.

b) The contribution of the Funds to the goals of EU cohesion policy will be maximum, such us: reducing disparities and increasing growth, competitiveness and employment.

c) The financial allocation for the following programming period will be in the same situation like the others two.

[2] Florio, M. (2006): *Cost-benefit analysis and incentives in infrastructure planning and evaluation: a research agenda for the EU cohesion policy,* Paper prepared for the V Milan European Economy Workshop, University of Milan, 26-27 May.

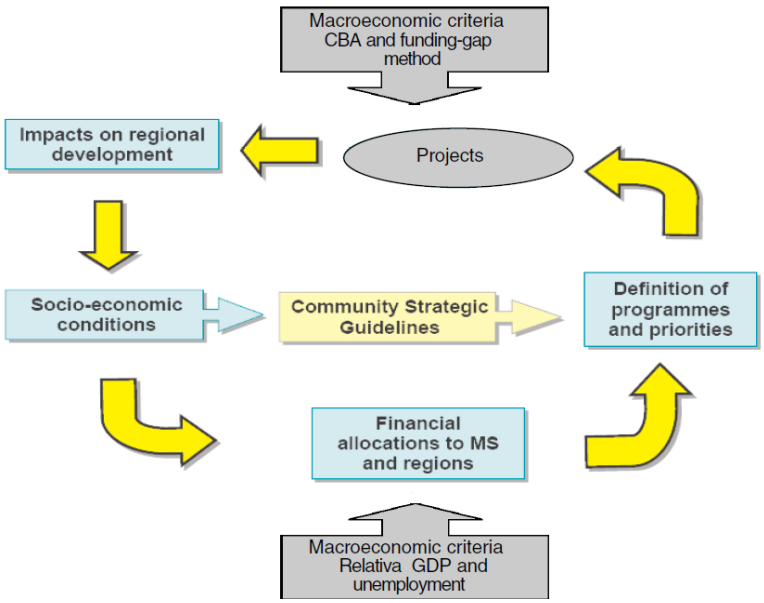


Figure 1. The allocation of resources through the programming cycle.

Source: Mairate, Angelini (2007).

As an example, for these, the managing authorities may be tempted to spend the money recklessly in order to remain in the Convergence objective without risking having its financial allocation reduced in the future.

In general, it is a trend to create operational potential information asymmetries by the nature of the governance system in which the Funds operate. Without affecting the post-accessing period, the Commission cannot fully observe whether the projects selected by the managing authorities during the implementation of programmes are actually meant to contribute to the targets of the EU cohesion policy. The use of microeconomic criteria to allocate resources to projects represented of the managing authorities and help prevent potential moral hazard in the context of the initial allocation of resources to regions/member States and regions decided on the basis of macroeconomic criteria.

By making the grant of Community financial resources conditional upon the results of the CBA for major projects, the managing authorities in the member states should ask the following questions: is the project efficient through EU objectives? What is the optimal level of public resources to be granted to the project? Answering to these questions, CBA can serve its role of supporting investment decisions and ensuring an efficient allocation of public resources. In general speaking, these are not

easy questions to be answered, especially in the context of binding behind states or regions with weak administrative capacity that most typically lack the necessary technical expertise. This is why the Commission plays an important role by stimulating the development of sound project appraisal culture through capacity building actions.

3. The responsibility of applying the CBA

Since the inception of the Structural Funds, the Commission has provided detailed guidance to member States. In 2007, the Guide to Cost-Benefit Analysis was updated and provided more detailed guidance on different areas of intervention together with some indicative benchmarks on rates of return.

All new Member States are responsible for applying the provisions laid down in the regulations, especially for projects below the threshold of 50 million euro. For major projects, the Commission decides and sets the contribution from the funds on the basis of the information contained in the application for funding. For increasing the responsibility of member States, the Commission has encouraged the development of national CBA settings, which are meant to provide common working rules to be used by national project promoters. Such methodological documents were elaborated fist to 25 EU States and then for 28. These guidelines can also be used by any member who is commissioning CBA studies as well as by the Commission services for reviewing their quality.

In particular, the Commission's working document recommends a financial discount rate of 5% in real terms as a benchmark for the appraisal of public sector funded projects under Structural and Cohesion Funds interventions.

This proposal has raised several issues relating to the choice of the financial discount rate as well as the need to differentiate social discount rates according to different target regions[3] In case of public-private partnerships projects, the Commission suggests that the financial discount rate may be increased to reflect a higher opportunity cost of capital to the private investor.

Another issue, which is partly linked to the enlargement of the Union, is the lack of maturity of large scale infrastructure projects. As a result, decision making procedures tend to be longer than for member States

[3] Florio, M. (2006a): *Cost-Benefit Analysis and the European Union Cohesion Fund: on the social cost of capital and labour*, Regional Studies, 40 (2).

which have more experience in preparing and designing similar projects. For a good efficiency, a new initiative has been launched to assist member States in the preparation of their projects: JASPERS (Joint Assistance for Preparing Projects in European Regions). So this operational support is provided for performing CBA studies in line with the Commission's guidelines.

The result is positive so far, as it has contributed to improvement of the quality of projects which potentially should lead to better socio-economic impacts.

4. The future of this kind of economic evaluation

The paper outlined the main challenges that underlie the challenges to a rigorous application of CBA in the context of the EU cohesion policy. Capacity-building actions for the member states need to be further strengthened, especially in the context of the enlargement to countries, namely Romania and Bulgaria. First of all, there is still need to increase assistance to member States with weak administrative capacity to perform their tasks, especially through technical assistance facilities such as JASPERS. Then it is essential to agree common rules for project applications and ensure proper application of EU guidance to national contexts.

This approach will bring substantial benefits in terms of simplification both for the Commission and member States, and thereby contribute to increase efficiency, in present the situation of absorption rate in Romania, terms of speeding up decision making procedures for major projects. As a result of our calculations we can say that the impact of financial crisis triggered in 2008 so severe that significantly overturned the initial estimates of funds absorption it will also have an important capacity building effect with a view to enhancing accountability and transparency.

The co-financing rules are likely to create incentives for project promoters to charge the users up to the affordable level. This should in turn favor the participation of private investors and contribute to the financial sustainability of projects in the longer term. Considering the crucial importance of these issues, it will be necessary to undertake further analytical work, with the help of academics and practitioners, in order to avoid potential adverse effects and to maximize economic efficiency through investment projects.

The main purpose is not a radical rethinking of CBA, but rather to make further advances building on current practice to give a new impulse to the e to the economic evaluation of projects and policies.

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